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## The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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## Abstract

### Introduction

Community health workers (CHWs) are increasingly being tasked to prevent and manage cardiovascular disease and its risk factors in underserved populations in low and middle income countries (LMIC); however, little is known about the required training necessary for them to accomplish their role. This review aimed to evaluate the training of CHWs for the prevention and management of cardiovascular disease and its risk factors in LMIC.

### Methods

A search strategy was developed in line with PRISMA guidelines and 5 electronic databases (Medline, Global Health, ERIC, EMBASE and CINAHL) were searched to identify peer reviewed studies published till December 2015 on the training of CHWs for prevention or control of cardiovascular disease and its risk factors in LMIC. Study characteristics were extracted using a Microsoft excel spread sheet and quality assessed using Effective Public Health Practice Project's Quality Assessment Tool. The search, data extraction and quality assessment were performed independently by two researchers.

### Results

The search generated 720 articles of which six were included in the review. One study was a randomised controlled trial while the remaining were before-after intervention studies. The training methods included classroom lectures, some of which were held at the field site, interactive lessons, e-learning and online support, and group discussions or a mix of two or more. All the studies showed improved knowledge level post-training and two studies demonstrated knowledge retention six months after the intervention.

### Conclusion

This review demonstrates that there is little information about CHW training for CVD prevention and control. The six studies included in the review indicate that CHWs can be trained effectively for CVD prevention and management, leading to improvement in knowledge, skills and performance. However, well conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and cost-effectiveness of training programs.

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**Strengths and limitations of this study**

- First systematic review to evaluate the effectiveness of training community health workers for the prevention and management of cardiovascular disease and its risk factors in Low and Middle Income Countries.
- The review was conducted in accordance to the PRISMA guidelines.
- Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)’s Quality Assessment Tool.
- A meta-analysis was not performed due to heterogeneity of the studies and data provided.

For peer review only

## INTRODUCTION

### Cardiovascular Diseases in developing countries

Globally, the burden of non-communicable diseases (NCDs) is rising with the cause specific mortality fraction due to NCDs estimated to be 69% in 2030 compared to 59% in 2002.<sup>1</sup> This shift is largely driven by a demographic and epidemiologic transition, coupled with rapid urbanization and nutritional transitions in developing countries.<sup>2</sup> Currently, cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the developed and developing countries alike, with a greater burden being felt by the latter, as they carry a higher proportion of premature deaths from cardiovascular events.<sup>3,4</sup> Most health systems in low- and middle-income countries (LMICs) are unprepared to manage the increasing burden of CVDs as their health systems are often focused on infectious diseases and maternal and child health, rather than chronic diseases.<sup>5,6</sup>

### The health workforce for CVD

Access to primary care for CVD prevention and treatment in LMIC can often be challenging<sup>7</sup> as these countries have the highest global disease burden and tend to experience some of the greatest shortages in physicians and health workers.<sup>8</sup> For example, there are 2.3 health workers per 1000 population in Africa, and 4.3 per 1000 population in South-East Asia.<sup>9</sup> A maldistribution of these health workers often exist with a higher concentration of health workers in urban areas compared to rural regions where large proportions of the population resides.<sup>9-11</sup> This poor distribution and shortage of health professionals has led some countries to rely on trained community health workers (CHWs), who take on specific tasks for the prevention and management of diseases.

### Community health workers

The World Health Organisation (WHO) defines CHWs as individuals who perform functions related to health-care delivery; have shorter training than professional health workers, are community members, selected by and answerable to the community for their activities and are usually supported by the health system but not necessarily a part of its organization. Typically, they are trained for

specific tasks such as provision of antenatal care or immunisation and often do not hold any formal certifications.<sup>12</sup> CHWs have been effective in providing essential health care services in a cost-effective manner.<sup>13, 14</sup> They have been instrumental in reducing maternal and neonatal mortality rates through their presence in at-home births and making referrals for emergency obstetric care,<sup>15-17</sup> and by promoting vaccination uptake, breastfeeding, and education on infectious disease.<sup>18, 19</sup> More recently, CHWs have been useful in HIV/AIDS prevention and control, educating communities and performing tasks such as testing, counselling and prescribing antiretroviral drugs.<sup>20-24</sup> This transfer of responsibilities onto CHWs is commonly referred to as task shifting, which is common in regions with limited access to physicians.<sup>25-27</sup> This increase in responsibility has been noted throughout the global health community, and it is not uncommon for CHWs to hold different titles based on the country where they work or the tasks for which they are responsible (such as non-physician healthcare worker, lay health worker, traditional birth attendant, accredited social health activist, Barangay Health worker, etc.).<sup>12</sup>

Over the last 5 years, CHWs have had an increasing role in CVD prevention and control.<sup>28-31</sup> Although research into the effect of CHWs in CVD prevention and control is relatively new, there is emerging evidence which yields promising results.<sup>32-35</sup> There is considerable amount of data and manuals available to help train CHWs for management of infectious diseases and maternal and child health in LMIC;<sup>36-38</sup> however, there is a lack of evidence based information regarding the content and method to train CHWs for CVD prevention and control.<sup>39</sup> Effective training and re-training are essential for the knowledge and skill-set required for good quality performance. This systematic review aims to provide comprehensive insight into CHW training programs for CVD prevention and control, and provides an evidence base for the effectiveness of training programs in the LMIC context.

**METHODS**

A protocol was written to define the inclusion and exclusion criteria and the methods for the review prior to data extraction in accordance to the PRISMA guidelines.<sup>40</sup> Five data bases including Medline

via OvidSP, Global Health via OvidSP, ERIC via OvidSP, Embase via OvidSP, and CINAHL via EBSCO were reviewed.

### **Inclusion and exclusion criteria**

The population considered for this systematic review was CHWs in LMICs. Synonyms for CHWs included in the search were taken from the WHO report on CHWs,<sup>12</sup> and other terms based on literature reviews.<sup>41, 42</sup> The intervention sought after was training programs for CHWs in CVD and cardiovascular risk factor prevention (screening, health promotion) or control (monitoring, management). Papers included were specific in what type of training methods were used, i.e. which topics were covered, length and outcomes of the training programs, etc. Studies were limited to CVDs and their modifiable risk factors including high blood pressure, diabetes, dyslipidaemia, alcohol consumption, tobacco use and physical inactivity. A complete list of free text search terms and subject headings are supplied in Appendix 1. The comparator variable for this paper included usual training or before training and the outcome of interest was an improvement in skills and knowledge of CHWs in the prevention and control of CVDs and their risk factors. Types of studies included were pre-post observational studies, and randomised controlled trials published till 31 December, 2015. Papers in all languages were searched but only those published in English were included, one study was found in Portuguese hence it was not included. If a study was reported in more than one paper, information from all the papers was included in the review, but the study was counted as once.

Studies were limited to those which were explicit in specifying what type of training was done and reported pre-post test scores for CHWs. They included countries classified during 2015 as low-, lower-middle, and upper-middle income countries in the World Bank's Income Classifications.<sup>43</sup>

### **Data collection**

After agreeing on the search strategy to be used, two authors (BP, MA) reviewed the literature and extracted the data independently. The number of studies included at each stage of literature search



was agreed upon between the two authors to ensure no papers were missed.(Figure 1) Data was collected on a pre-specified excel sheet after approval of all reviewers, with variables clearly outlined. The first paper to be included was extracted independently then the data was compared between authors to confirm what was to be expected to report for each variable. This sheet was modified to include all information that was important as data extraction continued. Weekly meetings were held between the data extractors to discuss any disagreements about the inclusion of a paper. If any disagreements, a third author (RJ) was asked to adjudicate. At the end of data extraction, all reviewers met to note any discrepancies and agree on the final data extraction. The references of all the included papers were checked for additional relevant papers. Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)'s Quality Assessment Tool.<sup>44</sup> The Tool provide an overall methodological rating of the studies of strong, moderate or weak as per six components including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts. No study was excluded based on the quality assessment.

To demonstrate the change in knowledge and skills among CHWs, pre- and post-test scores and post intervention scores, published in the six papers were used to evaluate the effectiveness of training in improving the knowledge and skill level of CHWs. The qualitative data provided was used to assess the CHWs perception and experience of the training. A meta-analysis was not performed due to heterogeneity of the studies.

**RESULTS**

**Characteristics of included studies, CHWs and trainers**

The initial search yielded 720 citations published between the period of 1959 and 2015. After removing duplicates 661 abstracts were screened, of which 83 were assessed for a full review and six were included. Figure 1 outlines the systematic review process. The selected studies were conducted between the year 2000 and 2013, and published between the year 2007 and 2015. Four of the studies were conducted in rural or semi-urban areas and two studies did not mention details about the study

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3 site.<sup>45, 46</sup> None of the studies discussed the cost of training involved or the cost-effectiveness of the  
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5 training.  
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8 The studies included Community Health Workers from Bangladesh, Guatemala, Mexico, South  
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10 Africa<sup>47</sup> and Thailand,<sup>48</sup> Barangay Health Workers in the Philippines,<sup>49</sup> Lady Health Workers in  
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12 Pakistan,<sup>50</sup> Healthcare Volunteers in Thailand,<sup>45</sup> and Community Health Agents from Brazil.<sup>46</sup> The  
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14 number of trained health workers varied from 3548 to 29950 and were mostly women (75-100%). The  
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16 education of CHWs varied from primary school<sup>45, 49</sup> to Master Degree holders.<sup>47, 48</sup> In most studies, the  
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18 health workers were part of the health system receiving a salary, except in Guatemala where a  
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20 monthly incentive was provided<sup>47</sup> and Thailand, where CHWs were volunteers from the  
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22 community.<sup>45</sup> The training team included health professionals,<sup>47</sup> project officers<sup>50</sup> and  
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24 researchers.<sup>46</sup> Two studies did not provide details about the trainers.<sup>45, 48</sup> Detailed characteristics of  
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26 the CHWs and trainers are provided in Table 1.  
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**Table1: Characteristics of Community Health Workers and Trainers**

Study	Type of Health workers (Country of study)	Number of CHWs	Sex	Age	Education	Relation to health system	Trainers
Abrahams-Gessel S et al, 2015 <sup>47</sup>	Community Health Worker (Bangladesh, Guatemala, Mexico & South Africa)	64	84% Females	Not reported	B: Secondary to Master's Degree, G: Secondary, M: Secondary, SA: Secondary	B: NGO employed G: NGO employed M: Government employed SA: NGO employed	Health professionals: physicians, nurses, and nutritionists
Ku GM V et al, 2014 <sup>49</sup>	Barangay Health Worker (Philippines)	87	Not reported	Not reported	Primary (8%), Secondary (42%), College degree (50%)	Government employed	Principal investigators and trained nurses
Nishtar S et al, 2007 <sup>50</sup>	Lady Health Worker (Pakistan)	299	100% Females	Not reported	Not reported	Government employed	Heartfile Officer (project officer)
Sangprasert P, 2011 <sup>45</sup>	Healthcare Volunteer (Thailand)	75	75% Females	Mean age 49.5	Primary (56.4%), Secondary (30.1%), Diploma (9.7%), Bachelor's (3.8%)	Volunteers	Not reported
Silva SSB E et al, 2010 <sup>46</sup>	Community Health Agents (Brazil)	37	90.9% Females	50% of CHWs were up to 40 years	Secondary (67.3%)	Government employed	Researchers
Sranacharoenpong K et al, 2012 <sup>48</sup>	Community Health Care Worker (Thailand)	35	97% Females	25-34y – (17%), 35-44y – (63%), 45-54y – (20%)	Diploma (5.7%), Bachelor's (88.6%), Master's (5.7%)	Government employed	Not reported

Note: B (Bangladesh) / G (Guatemala) / M (Mexico) / SA (South Africa)  
NGO (Non-governmental organization)

### Details regarding training methods

Studies used different approaches to develop the curriculum and disseminate knowledge. Training methods included interactive modes like problem-based learning, classroom discussions, demonstrations, media presentations as well as self-training quizzes and assignments, which were either online<sup>48</sup> or paper based.<sup>47</sup> Training designs included the T5 instructional learning design (Tasks, tutorials, tools, topics, and teamwork) allowing interactive learning,<sup>51</sup> or adapting existing education and training materials available from high income countries.<sup>47</sup> In one of the studies, CHWs were trained alongside nurses on hypertension, its treatment and its burden through interactive classes.<sup>46</sup> The training varied, from 6 hours<sup>50</sup> up to 40 hours<sup>48</sup> over a four to six month period. (Table 2) Training took place in classrooms at the local health units in three studies<sup>46, 48, 50</sup> while the other three studies did not mention details about the training site. Training focused on CVD and its risk factors, healthy lifestyle and dietary habits and physical activity. Four of the studies<sup>45, 47-49</sup> trained CHWs on anthropometric measurement skills and their interpretation. Please see Table 3 for details about training content of each study.

**Table 2: Training methods and duration for CVD and its risk factors management for CHWs in LMICs**

Study	Training details	Duration of training program	Methods of training (workshop, online)
Abrahams-Gessel S et al, 2015 <sup>47</sup>	Non-invasive screening of cardiovascular risk score	2 weeks training over a 4 month period	Lectures and interactive lessons. On-site training for anthropometric measurements, CVD risk score calculation
Ku GM V et al, 2014 <sup>49</sup>	Diabetes knowledge and basic skills practices development	32 hours	Lectures, two-way demonstrations, hands-on workshops
Nishtar S et al, 2007 <sup>50</sup>	Cardiovascular disease prevention	6 hour sessions	Interactive training workshops
Sangprasert P, 2011 <sup>45</sup>	Hypertension knowledge and basic skills practices development	Not reported	Lectures and group discussions
Silva SSB E et al, 2010 <sup>46</sup>	Hypertension knowledge and basic skills practices development	11 sessions fortnightly over 6 months, 16.5 hours total	Lectures and practical sessions
Sranacharoenpong K et al, 2012 <sup>48</sup>	Hypertension knowledge and basic skills practices development	16 sessions, 2.5 hours each over 4 months	Lectures and group discussion, problem-based learning e-learning and online support Community-based application, assignments, self-evaluation

**Table 3: Training content for CVD and its risk factors management for CHWs in LMICs**

	Knowledge	Skills
<b>Abrahams-Gessel S et al, 2015<sup>47</sup></b>	Cardiovascular disease and its risk factors	Blood pressure measurement, Weight and height measurements and BMI calculation, Obtaining a 5-year CVD risk score using a "Risk scoring Chart"
<b>Ku GM V et al, 2014<sup>49</sup></b>	Diabetes diagnosis and management Foot care Diabetic diet and dietary counselling Physical activity	Anthropometric measurements (weight, height, waist and hip circumference), BMI and waist-hip ratio calculation and their interpretation. Blood pressure and blood glucose measurement, Psychosocial skills development ( active listening, patient and family empowerment and social mobilization)
<b>Nishtar S et al, 2007<sup>50</sup></b>	Blood pressure measurement importance and desired frequency, Healthy life style and its role in preventing CVD and its complications	N/A
<b>Sangprasert P, 2011<sup>45</sup></b>	Health promotion and health education practices, Healthy dietary habits, Physical activity, Relaxation skills	Blood pressure measurement, Weight, height and waist and hip circumference measurements BMI calculation and its interpretation
<b>Silva SSB E et al, 2010<sup>46</sup></b>	Hypertension and its treatment, Epidemiological data regarding hypertension to clarify its problem, Healthy lifestyle promotion, Treatment adherence and its importance	N/A
<b>Sranacharoenpong K et al, 2012<sup>48</sup></b>	Healthy dietary habits and providing proper dietary recommendations, Physical activity and motivating at-risk population	Weight, height and waist circumference measurements and their interpretation

**Impact of the training on knowledge and skills**

All the studies assessed the knowledge<sup>46, 50</sup> and four of them assessed knowledge and skills<sup>45, 47-49</sup> before and after the training sessions. In addition, two studies evaluated the effect of training at 2-3 months<sup>47</sup> and 8 months after the intervention study.<sup>48</sup> Pre- and post-training scores were reported by all studies as a measure of effectiveness of training. Of the six studies included in the review, we could use scores from five studies; the sixth study<sup>45</sup> could not be included in the figure as the measure of test scores was not described. All the studies showed increase in the knowledge scores among CHWs pre- and post-training ranging from 3%<sup>46</sup> to 50%.<sup>47</sup> In the two studies (including five sites) which assessed the knowledge post-intervention, the knowledge level of CHWs in Bangladesh did not change, the CHWs in Guatemala<sup>47</sup> showed an average increase of 27%, and the scores of CHWs in Mexico, South Africa<sup>47</sup> and Thailand<sup>48</sup> decreased over time. Figure 2 provides details regarding the test scores.

In addition, two projects used qualitative methods to assess the potential challenges and enablers of CHW training programs, through observation, interviews, and focus group discussions.<sup>47, 52, 53</sup> CHWs preferred a minimum 2-week training program with interactive classes. Since this was the first time many CHWs were offered training in such a setting, it wasn't clear to them what to expect from the training session or workshops. Language barrier was another challenge, as the training manual was written in the local language, while the medium of instruction was in English, this made it difficult for the CHWs to link the manual with the verbal instructions provided. Barriers experienced while working in the field included gender issues such as taking anthropometric measurements of the opposite sex, lack of trust among community to share their health concerns with CHWs, safety and other cultural issues.<sup>47</sup> In addition, heavy workload, underestimation of the time required to carry out the work and low remuneration provided were other barriers raised by CHWs. In terms of frequency of access to learning materials and satisfaction with the training program (including length, methods, and usefulness of the program, computer skills and using electronic and paper-based materials),

CHWs seemed satisfied with the content of training program, and the assignments. However, about 46% did not feel that computer skills were easy to learn.

### Study quality

One out of the six studies was a randomised controlled trial,<sup>48</sup> while the others were pre- and post-observational studies. The CHW retention rates varied across the studies from 77%<sup>47</sup> to 88%<sup>49</sup> with two studies retaining 100% of CHWs,<sup>46, 48</sup> and one study not reporting CHW turnover during the study period.<sup>45</sup> Detailed information about CHWs,<sup>50</sup> trainers,<sup>45, 48</sup> development of the training program<sup>46, 50</sup> and process of knowledge evaluation<sup>50</sup> was not reported in some studies. The quality of all included studies was assessed using Effective Public Health Practice Project's (EPHPP) Quality Assessment Tool.<sup>44</sup> Evaluated across six quality domains, each study was assessed with the potential of an overall rating of weak, moderate or strong. The quality of one study was rated moderate.<sup>48</sup> The others were rated weak. Please see Table 4 for details of the quality assessment for each of the six quality domains.



**Table 4: Assessment of the quality of included studies using the EPHPP tool<sup>44</sup>**

Study	Selection bias*1	Study Design*2	Confounders*3	Blinding*4	Data Collection Methods*5	Withdrawals and Drop-outs*6	Overall Rating
Abrahams-Gessel S et al, 2015 <sup>47</sup>	Weak	Moderate	Weak	Weak	Moderate	Weak	<b>Weak</b>
Ku GM V et al, 2014 <sup>49</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Strong	<b>Weak</b>
Nishtar S et al, 2007 <sup>50</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Weak	<b>Weak</b>
Sangprasert P, 2011 <sup>45</sup>	Moderate	Moderate	Moderate	Weak	Moderate	Weak	<b>Weak</b>
Silva SSB E et al, 2010 <sup>46</sup>	Moderate	Moderate	Moderate	Weak	Weak	Moderate	<b>Weak</b>
Sranacharoenpong K et al, 2012 <sup>48</sup>	Strong	Strong	Moderate	Weak	Strong	Strong	<b>Moderate</b>

1. Likelihood of the participants to be representing the target population.  
2. The likelihood of bias due to allocation process in the study design.  
3. Effect of variables associated with the intervention and causally related to the outcome of interest.  
4. Likelihood of protection against reporting bias.  
5. Reliability and validity of outcome measures.  
6. Assessment of the description of numbers and reasons for withdrawals and drop-outs.

## DISCUSSION

In this review, we assessed the effectiveness of training CHWs for the prevention and management of CVD and its risk factors. We reviewed six studies, which were focussed on CVD, hypertension, or diabetes. This review demonstrates that CHWs with low levels of formal education can be trained effectively for CVD and risk factor prevention and management. The knowledge and skill set of CHWs improved in the immediate post training period for all studies and varied in performance in the 6-8 months after the initiation of the intervention. The qualitative studies indicated that interactive training, hands-on workshops and case scenarios were preferred over traditional didactic training. Training sessions adapted to local culture and delivered in the local language were found to be easier for the CHWs to understand and retain. Understanding the cultural norms and local dialects were essential components to deliver the training to CHWs. The review also demonstrates that knowledge acquired during training seemed to be retained for up to six months post-training, suggesting that further re-training or refresher training might be needed for long term improvement in knowledge and consequent improved health outcomes for the community.

A review of CHW training for maternal and child health related conditions found that without re-training, acquired skills and knowledge are lost relatively quickly.<sup>54</sup> While training is an important determinant of performance, other factors related to training include recognition of competence in skills to perform related tasks. Hence, contemporary CHW training programs now include competency based training rather than the traditional knowledge based training. Recent reviews on task-shifting from physicians to non-physicians for management of CVD and other NCDs in LMIC have found that training, close supervision and feedback are essential for the success of task-shifting interventions.<sup>25, 55</sup> Training of CHWs occurs through formal schooling, in-service training and on-the-job experience; and these, coupled with the working environment, supervision, motivation, career growth, and incentives determine the long term effectiveness and performance of CHWs,<sup>56</sup> which ultimately impacts on the health of individuals in the community.

Over the last five years, there have been several studies involving CHWs for the prevention and management of CVD risk factors via complex multifaceted interventions in LMICs.<sup>57, 58</sup> While most studies that involve CHWs include a component of training, none of them report the content, length or effectiveness of training on CHWs. Studies from South Africa,<sup>59, 60</sup> Pakistan,<sup>61</sup> India,<sup>62-64</sup> China,<sup>65</sup> Dominic Republic,<sup>66</sup> Guatemala,<sup>67</sup> Thailand,<sup>68</sup> Mexico<sup>69</sup> and the Mexican-US border<sup>70</sup> have shown innovative ways of involving CHWs for the prevention and control of CVD and its risk factors. However, these studies did not measure the impact of training on CHW knowledge and skill set.

Testing knowledge and skills via pre- and post-training tests does not necessarily reflect the trainee's competence and successful demonstration of behaviour change or change in capability. Standardized measures need to be considered for quality and efficacy assessment of CHW training programs. Few standardized tools and methods for training evaluation and effectiveness assessment are available<sup>71-74</sup> which focus on the short-term and long-term outcomes of the training. Kirkpatrick's Four-Level Training Evaluation Model<sup>74</sup> is one such method which is based on evaluating the trainees' reaction to the training program, improvement in knowledge, the degree to which they apply the knowledge, and the long-term outcomes. Kaufman's 5 Levels of Evaluation<sup>73</sup> is another standard for evaluating the effectiveness of training which evaluates the training design, materials and resources used and the final outcome on the whole community and the trainee. Using standardized methods of evaluation allows better comparison and interpretation of the data.

Research is needed to understand the training needs; CHW and community requirements for the successful roll out of CHW focused interventions on CVD prevention and control. Randomised controlled trials involving CHWs should provide details about the CHW characteristics, curriculum development, training provided and impact of the training, and these should ideally be costed. Mixed methods studies would give a better understanding of the challenges involved with implementing training programs for CHWs and provide evidence for best practice. Training design should consider the current roles of the CHWs and how the new skills should complement this role. Training should include demonstration, simulation and on the job supervision to improve confidence of CHWs with

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2  
3 their newly learned skills. Communication skills training should focus on changing social norms and  
4 behaviours and encouraging the community to work on local fears and myths. CHW attitudes,  
5 expression of respect, responsibility and concern should be addressed in training design to assure  
6 development of appropriate relationship between the CHWs and the patients and rest of the  
7 community.<sup>75</sup> With the available mobile conferencing platforms, follow-up training can be provided  
8 to many trainees at a time, remotely as well. Training should be provided onsite where CHWs  
9 perform their roles, evidence suggest that onsite training tends to cost less and cause less disruption of  
10 the routine functioning of health services, compared to offsite training.<sup>76</sup> Better training programs  
11 alone will not solve the problems related to opportunities for career growth and professional  
12 development via continuing education; the chance to move to the next level within the health system  
13 would help motive CHWs to stay in the workforce.<sup>54</sup> Attention needs to be paid to CHW  
14 remuneration and career development as these are noted challenges affecting the retention of trained  
15 CHWs in the workforce. Governments should adopt innovative national planning and provide suitable  
16 financial and legal support to ensure the sustainability of implemented programs.<sup>77-80</sup> Researchers  
17 should consider making the tool kits and resources for CVD management publically available to other  
18 researchers and governments.

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21 In conclusion, this review demonstrates that there is not much information about CHW training for  
22 CVD prevention and control in LMICs. The limited evidence indicates that CHWs can be trained in  
23 CVD and risk factor prevention and management and can benefit from refresher training. Well  
24 conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and  
25 cost-effectiveness of training programs.

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**Ethics approvals**

An ethics committee approval was not required for this paper as it involved secondary analysis of publically available data.

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**Conflict of Interest**

None declared

**Author Contributions**

BP drafted the protocol under the supervision of RJ. BP and MA performed the search, extracted the data, and contributed towards the interpretation of the results. MA wrote the first draft. RJ conceived the research question, supervised the review and approved the final version of the manuscript. DP and SA provided critical input towards the manuscript. All the authors reviewed the final draft.

## References

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med* 2006;3(11):e442. doi: 10.1371/journal.pmed.0030442
2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. 1971. *Milbank Q* 2005;83(4):731-57. doi: 10.1111/j.1468-0009.2005.00398.x
3. Cardiovascular diseases (CVDs). World Health Organization. Fact sheet 2016 [Available from: <http://www.who.int/mediacentre/factsheets/fs317/en/> accessed October 2016.
4. Celermajer DS, Chow CK, Marijon E, et al. Cardiovascular disease in the developing world: prevalences, patterns, and the potential of early disease detection. *Journal of the American College of Cardiology* 2012;60(14):1207-16. doi: 10.1016/j.jacc.2012.03.074
5. Maher D, Ford N, Unwin N. Priorities for developing countries in the global response to non-communicable diseases. *Global Health* 2012;8:14. doi: 10.1186/1744-8603-8-14
6. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation* 1998;97(6):596-601.
7. Rural Health Statistics in India-2010: Ministry of Health and Family Welfare. Government of India.
8. Scheffler RM, Liu JX, Kinfu Y, et al. Forecasting the global shortage of physicians: an economic-and needs-based approach. *Bulletin of the World Health Organization* 2008;86(7):516-23B.
9. The World Health Report 2006: Working together for health: World Health Organization, 2006.
10. Sharma DC. India still struggles with rural doctor shortages. *The Lancet* 2015;386(10011):2381-82.
11. Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. *The Lancet* 2004;364(9449):1984-90.
12. Lehmann U, Sanders D. Community health workers: what do we know about them. *The state of the evidence on programmes, activities, costs and impact on health outcomes of using community health workers Geneva: World Health Organization* 2007:1-42.
13. Vaughan K, Kok MC, Witter S, et al. Costs and cost-effectiveness of community health workers: evidence from a literature review. *Hum Resour Health* 2015;13(1):71. doi: 10.1186/s12960-015-0070-y
14. Neupane D, Kallestrup P, McLachlan CS, et al. Community health workers for non-communicable diseases. *Lancet Glob Health* 2014;2(10):e567. doi: 10.1016/S2214-109X(14)70303-1
15. Gilmore B, McAuliffe E. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low-and middle-income countries: a systematic review. *BMC Public Health* 2013;13(1):1.
16. Tran N, Portela A, de Bernis L, et al. Developing Capacities of Community Health Workers in Sexual and Reproductive. *Maternal, Newborn* 2014
17. Lawn J, Kerber K. Opportunities for Africa's newborns: practical data policy and programmatic support for newborn care in Africa. 2006
18. Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. *Cochrane Database Syst Rev* 2010(3):CD004015. doi: 10.1002/14651858.CD004015.pub3
19. Lassi ZS, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. *Cochrane Database Syst Rev* 2015;3:CD007754. doi: 10.1002/14651858.CD007754.pub3
20. Mwai GW, Mburu G, Torpey K, et al. Role and outcomes of community health workers in HIV care in sub-Saharan Africa: a systematic review. *Journal of the International AIDS Society* 2013;16(1)
21. Huicho L, Scherpbier RW, Nkowane AM, et al. How much does quality of child care vary between health workers with differing durations of training? An observational multicountry study. *The Lancet* 2008;372(9642):910-16.
22. Hermann K, Van Damme W, Pariyo GW, et al. Community health workers for ART in sub-Saharan Africa: learning from experience—capitalizing on new opportunities. *Human resources for health* 2009;7(1):1.

23. Schneider H, Hlophe H, van Rensburg D. Community health workers and the response to HIV/AIDS in South Africa: tensions and prospects. *Health policy and Planning* 2008;23(3):179-87.

24. Simon S, Chu K, Frieden M, et al. An integrated approach of community health worker support for HIV/AIDS and TB care in Angonia district, Mozambique. *BMC International Health and Human Rights* 2009;9(1):1.

25. Joshi R, Alim M, Kengne AP, et al. Task shifting for non-communicable disease management in low and middle income countries—a systematic review. *PLoS one* 2014;9(8):e103754.

26. Lehmann U, Van Damme W, Barten F, et al. Task shifting: the answer to the human resources crisis in Africa? *Hum Resour Health* 2009;7:49. doi: 10.1186/1478-4491-7-49

27. Joshi R, Santo, K., Redfern, K. Task shifting for cardiovascular disease management: What can we learn from other models? *Journal of Cardiology and Therapy* 2014;1(5):65-73.

28. Abegunde DO, Shengelia B, Luyten A, et al. Can non-physician health-care workers assess and manage cardiovascular risk in primary care? *Bull World Health Organ* 2007;85(6):432-40.

29. Raphael JL, Rueda A, Lion KC, et al. The role of lay health workers in pediatric chronic disease: a systematic review. *Acad Pediatr* 2013;13(5):408-20. doi: 10.1016/j.acap.2013.04.015

30. Balcazar HG, de Heer HD. Community health workers as partners in the management of non-communicable diseases. *Lancet Glob Health* 2015;3(9):e508-9. doi: 10.1016/S2214-109X(15)00142-4

31. Mohan V, Deepa M, Pradeepa R, et al. Prevention of diabetes in rural India with a telemedicine intervention. *J Diabetes Sci Technol* 2012;6(6):1355-64.

32. Jafar TH, Islam M, Hatcher J, et al. Community based lifestyle intervention for blood pressure reduction in children and young adults in developing country: cluster randomised controlled trial. *BMJ* 2010;340:c2641.

33. Coleman R, Gill G, Wilkinson D. Noncommunicable disease management in resource-poor settings: a primary care model from rural South Africa. *Bull World Health Organ* 1998;76(6):633-40.

34. Farzadfar F, Murray CJ, Gakidou E, et al. Effectiveness of diabetes and hypertension management by rural primary health-care workers (Behvarz workers) in Iran: a nationally representative observational study. *Lancet* 2012;379(9810):47-54. doi: 10.1016/S0140-6736(11)61349-4

35. Alem A, Jacobsson L, Hanlon C. Community-based mental health care in Africa: mental health workers' views. *World Psychiatry* 2008;7(1):54-7.

36. Redick C, Dini H. The current state of CHW training programs in Sub-Saharan Africa and South Asia: What we know what we don't know and what we need to do. 2014

37. Waldman R. Health programming for rebuilding states: a briefing paper. 2007

38. 1mCHW workshop "FINANCING COMMUNITY HEALTH WORKER SYSTEM AT SCALE WORKSHOP" IN ACCRA, GHANA. videos [Available from: <http://1millionhealthworkers.org/resources/videos/> accessed November 2016.

39. Pallas SW, Minhas D, Pérez-Escamilla R, et al. Community health workers in low-and middle-income countries: what do we know about scaling up and sustainability? *American journal of public health* 2013;103(7):e74-e82.

40. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine* 2009;151(4):264-69.

41. Lariosa T. The role of community health workers in malaria control in the Philippines. *The Southeast Asian journal of tropical medicine and public health* 1991;23:30-35.

42. Sharma R, Webster P, Bhattacharyya S. Factors affecting the performance of community health workers in India: a multi-stakeholder perspective. *Global health action* 2014;7

43. The World Bank. Country and Lending Groups, 2016.

44. Thomas H. Quality assessment tool for quantitative studies. *Effective Public Health Practice Project McMaster University, Toronto* 2003



45. Sangprasert P. The effects of a training program for the development of hypertension knowledge and basic skills practice (HKBSP) for Thai community healthcare volunteers. *Siriraj Medical Journal* 2011;63(5):163-67.
46. Silva SSBEd, Colósimo FC, Pierin AMG. The effect of educational interventions on nursing team knowledge about arterial hypertension. *Revista da Escola de Enfermagem da USP* 2010;44(2):488-96.
47. Abrahams-Gessel S, Denman CA, Montano CM, et al. The training and fieldwork experiences of community health workers conducting population-based, noninvasive screening for CVD in LMIC. *Global Heart* 2015;10(1):45-54. doi: <http://dx.doi.org/10.1016/j.gheart.2014.12.008>
48. Sranacharoenpong K, Hanning RM. Diabetes prevention education program for community health care workers in Thailand. *J Community Health* 2012;37(3):610-8. doi: <http://dx.doi.org/10.1007/s10900-011-9491-2>
49. Ku GMV, Kegels G. Integrating chronic care with primary care activities: enriching healthcare staff knowledge and skills and improving glycemic control of a cohort of people with diabetes through the First Line Diabetes Care Project in the Philippines. *Global Health Action* 2014;7(25286)
50. Nishtar S, Badar A, Kamal MU, et al. The Heartfile Lodhran CVD prevention project--end of project evaluation. *Promotion & education* 2007;14(1):17-27.
51. Salter D, Richards L, Carey T. The 'T5' Design Model: An Instructional Model and Learning Environment to Support the Integration of Online and Campus - Based Courses. *Educational Media International* 2004;41(3):207-18.
52. Sranacharoenpong K, Hanning RM. Developing a diabetes prevention education programme for community health-care workers in Thailand: formative findings. *Primary health care research & development* 2011;12(04):357-69.
53. Sranacharoenpong K, Hanning R, Sirichakwal P, et al. Process and outcome evaluation of a diabetes prevention education program for community healthcare workers in Thailand. *Education for Health* 2009;22(3):335.
54. Bhutta ZA, Lassi ZS, Pariyo G, et al. Global experience of community health workers for delivery of health related millennium development goals: a systematic review, country case studies, and recommendations for integration into national health systems. *Global Health Workforce Alliance* 2010;1:249-61.
55. Ogedegbe G, Gyamfi J, Plange-Rhule J, et al. Task shifting interventions for cardiovascular risk reduction in low-income and middle-income countries: a systematic review of randomised controlled trials. *BMJ open* 2014;4(10) doi: 10.1136/bmjopen-2014-005983
56. Rowe AK, de Savigny D, Lanata CF, et al. How can we achieve and maintain high-quality performance of health workers in low-resource settings? *The Lancet*;366(9490):1026-35. doi: 10.1016/S0140-6736(05)67028-6
57. Kamath DY, Xavier D, Gupta R, et al. Rationale and design of a randomized controlled trial evaluating community health worker-based interventions for the secondary prevention of acute coronary syndromes in India (SPREAD). *American Heart Journal* 2014;168 (5):690-97. doi: <http://dx.doi.org/10.1016/j.ahj.2014.07.029>
58. van de Vijver S, Oti S, Addo J, et al. Review of community-based interventions for prevention of cardiovascular diseases in low- and middle-income countries. *Ethn Health* 2012;17(6):651-76. doi: <http://dx.doi.org/10.1080/13557858.2012.754409>
59. Surka S, Edirippulige S, Steyn K, et al. Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers. *International Journal of Medical Informatics* 2014;83(9):648-54. doi: <http://dx.doi.org/10.1016/j.ijmedinf.2014.06.008>
60. Botes AS, Majikela-Dlangamandla B, Mash R. The ability of health promoters to deliver group diabetes education in South African primary care. *African Journal of Primary Health Care and Family Medicine* 2013;5(1)



61. Khan M, Kamal AK, Islam M, et al. Can Trained Field Community Workers Identify Stroke Using a Stroke Symptom Questionnaire as well as Neurologists?: Adaptation and Validation of a Community Worker Administered Stroke Symptom Questionnaire in a Peri-urban Pakistani Community. *Journal of Stroke and Cerebrovascular Diseases* 2015;24(1):91-99.

62. Balagopal P, Kamalamma N, Patel TG, et al. A community-based participatory diabetes prevention and management intervention in rural India using community health workers. *Diabetes Educ* 2012;38(6):822-34. doi: <http://dx.doi.org/10.1177/0145721712459890>

63. Xavier D, Gupta R, Kamath D, et al. Community health worker-based intervention for adherence to drugs and lifestyle change after acute coronary syndrome: a multicentre, open, randomised controlled trial. *The Lancet Diabetes & Endocrinology*;4(3):244-53. doi: 10.1016/S2213-8587(15)00480-5

64. Joshi R, Chow CK, Raju PK, et al. The Rural Andhra Pradesh Cardiovascular Prevention Study (RAPCAPS): a cluster randomized trial. *Journal of the American College of Cardiology* 2012;59(13):1188-96.

65. Dongbo F, Hua F, McGowan P, et al. Implementation and quantitative evaluation of chronic disease self-management programme in Shanghai, China: randomized controlled trial. *Bulletin of the World Health Organization* 2003;81(3):174-74 1p.

66. West-Pollak A, Then EP, Podesta C, et al. Impact of a novel community-based lifestyle intervention program on type 2 diabetes and cardiovascular risk in a resource-poor setting in the Dominican Republic. *International Health* 2014;6(2):118-24. doi: <http://dx.doi.org/10.1093/inthealth/ih039>

67. Micikas M, Foster J, Weis A, et al. A community health worker intervention for diabetes self-management among the Tz'utujil Maya of Guatemala. *Health Promotion Practice* 2015;16(4):601-08.

68. Saranrittichai K, Senarak W, Promthet S, et al. Health behavior after a multiprofessional intervention and training for ongoing volunteer-based community health programme intervention in the North-East of Thailand: what changed and what not? *Asian Pacific Journal of Cancer Prevention* 2012;13(9):4801-05.

69. Denman CA, Rosales C, Cornejo E, et al. Evaluation of the community-based chronic disease prevention program Meta Salud in Northern Mexico, 2011-2012. *Prev Chronic Dis* 2014;11:E154. doi: <http://dx.doi.org/10.5888/pcd11.140218>

70. Cornejo E, Denman CA, Sabo S, et al. Scoping review of community health worker/promotora-based chronic disease primary prevention programs on the US-Mexico border. *alamo colson edu mx* 2011;8085

71. Alvarez K, Salas E, Garofano CM. An integrated model of training evaluation and effectiveness. *Human resource development Review* 2004;3(4):385-416.

72. Wang GG, Wilcox D. Training evaluation: knowing more than is practiced. *Advances in Developing Human Resources* 2006;8(4):528-39.

73. Kaufman R, Keller JM. Levels of evaluation: beyond Kirkpatrick. *Human Resource Development Quarterly* 1994;5(4):371-80.

74. Bates R. A critical analysis of evaluation practice: the Kirkpatrick model and the principle of beneficence. *Evaluation and Program Planning* 2004;27(3):341-47. doi: <http://dx.doi.org/10.1016/j.evalprogplan.2004.04.011>

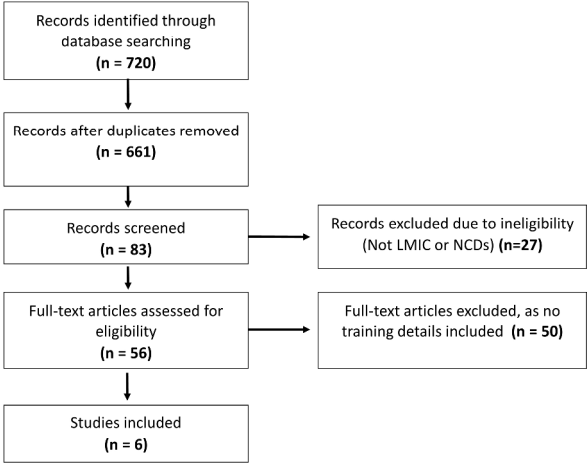
75. Perry H, Crigler L. Developing and strengthening community health worker programs at scale. A reference guide and case studies for program managers and policymakers. 2013

76. Ritchie LMP, Schull MJ, Martiniuk AL, et al. A knowledge translation intervention to improve tuberculosis care and outcomes in Malawi: a pragmatic cluster randomized controlled trial. *Implementation Science* 2015;10(1):1.

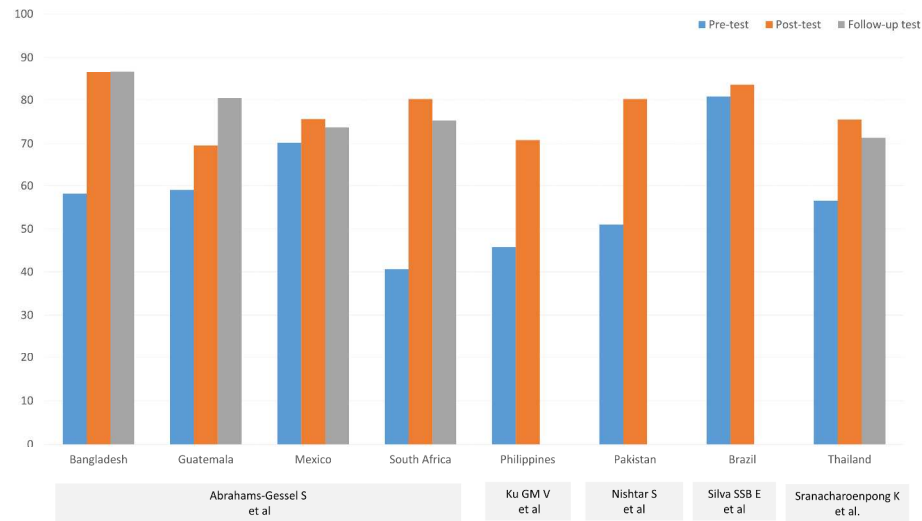
77. Kok MC, Dieleman M, Taegtmeier M, et al. Which intervention design factors influence performance of community health workers in low-and middle-income countries? A systematic review. *Health policy and planning* 2015;30(9):1207-27.

- 1  
2  
3 78. Abbey M, Bartholomew LK, Nonvignon J, et al. Factors related to retention of community health  
4 workers in a trial on community-based management of fever in children under 5 years in the  
5 Dangme West District of Ghana. *International health* 2014;6(2):99-105.  
6 79. Bhattacharyya K, Winch P, LeBan K, et al. Community Health Worker Incentives and Disincentives:  
7 How They Affect Motivation, Retention, and Sustainability. Published by the Basic Support  
8 for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for  
9 International Development. Arlington, Virginia.  
10 80. Research on community-based health workers is needed to achieve the sustainable development  
11 goals. Bulletin of the World Health Organization. November 2016 ed, 2016:786-86.  
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**APPENDIX 1**

Free text terms used in the databases on the OVID platform (Medline, Global Health, ERIC, Embase):

**CHW Group (Population)**

1. (Communit\* health\* adj3 (work\* or staff or employee\* or provider\* or distributor\* or surveyor\* or assistant\* or promoter\* or agent\*).tw.
2. (Non-physician health\* adj3 (work\* or staff or employee\* or provider\*).tw.
3. CHW.tw.
4. LHW.tw.
5. (Lay health\* adj3 (work\* or staff or employee\* or provider\*).tw.
6. Volunteer health\* work\*.tw.
7. Voluntary health\* work\*.tw.
8. Promotoras de salud.tw.
9. (rural health adj3 (auxiliar\* or motivator\*).tw.
10. Traditional midwi\*.tw.
11. TBA.tw.
12. Traditional birth attendant\*.tw.
13. Health\* promoter\*.tw.
14. Basic health\* work\*.tw.
15. Communit\* nutrition work\*.tw.
16. Communit\* resource person.tw.
17. (Female adj3 (multipurpose health\* work\* or volunteer\*).tw.
18. (Maternal and child health\* work\*).tw.
19. Mother coordinator\*.tw.
20. Outreach educator\*.tw.
21. Paramedic\* work\*.tw.
22. (Village health\* adj3 (work\* or helper\* or guide\*).tw.
23. Shasthyo Sebikas.tw
24. ASHA.tw
25. Female community health volunteer\*.tw

**LMIC Group (Population)**

1. LMIC.mp
2. ((Low or middle) adj income countr\*).mp
3. Developing countr\*.mp
4. South East Asia\*.tw
5. Southeast\* Asia\*.mp.
6. Sub-Saharan Africa\*.tw.

7. Sub-Saharan Africa\*.mp.
8. Afghan\*.mp.
9. Benin\*.mp.
10. Burkina\*.mp.
11. Burundi\*.mp.
12. Cambodia\*.mp.
13. Central African Republic\*.mp.
14. Chad\*.mp.
15. Comor\*.mp.
16. Congo\*.mp.
17. Eritrea\*.mp.
18. Ethiopia\*.mp.
19. Gambia\*.mp.
20. Guinea\*.mp.
21. Haiti\*.mp.
22. North Korea\*.mp.
23. Liberia\*.mp.
24. Madagas\*.mp.
25. Malawi\*.mp.
26. Mali\*.mp.
27. Mozambi\*.mp.
28. Nepal\*.mp.
29. Niger\*.mp.
30. Rwanda\*.mp.
31. Sierra Leone\*.mp.
32. Somalia\*.mp.
33. South Sudan\*.mp.
34. Tanzania\*.mp.
35. Togo\*.mp.
36. Uganda\*.mp.
37. Zimbabwe\*.mp.
38. Armenia\*.mp.
39. Bangladesh\*.mp.
40. Bhutan\*.mp.
41. Bolivia\*.mp.
42. Cape Verd\*.mp.
43. Cameroon\*.mp.
44. Cote d'Ivoire.mp.
45. Ivorian.mp.
46. Djibouti\*.mp.
47. Egypt\*.mp.
48. Salvador\*.mp.
49. Georgia\*.mp.
50. Ghana\*.mp.
51. Guatemala\*.mp.
52. Guyan\*.mp.
53. Hondura\*.mp.
54. India\*.mp.
55. Indonesia\*.mp.
56. Kenya\*.mp.
57. Kiribati\*.mp.

58. Kosov\*.mp.
  59. Kyrgyz\*.mp.
  60. Lao\*.mp.
  61. Lesotho\*.mp.
  62. Mauritania\*.mp.
  63. Micronesia\*.mp.
  64. Moldova\*.mp.
  65. Morocc\*.mp.
  66. Myanmar\*.mp.
  67. Burm\*.mp.
  68. Nigeria\*.mp.
  69. Pakistan\*.mp.
  70. Nicaragua\*.mp.
  71. Papua New Guinea\*.mp.
  72. Philippin\*.mp.
  73. Filipino.mp.
  74. Samoa\*.mp.
  75. Sao Tome\*.mp.
  76. Senegal\*.mp.
  77. Solomon\*.mp.
  78. Sri Lanka\*.mp.
  79. Sudan\*.mp.
  80. Swazi\*.mp.
  81. Syria\*.mp.
  82. Tajik\*.mp.
  83. Timor\*.mp.
  84. Ukrain\*.mp.
  85. Uzbek\*.mp.
  86. Vanuatu\*.mp.
  87. Vietnam\*.mp.
  88. West bank.mp.
  89. Gaza\*.mp.
  90. Yemen\*.mp.
  91. Zambia\*.mp.
  92. Albania\*.mp.
  93. Algeria\*.mp.
  94. Angola\*.mp.
  95. Azerbaijan\*.mp.
  96. Belarus\*.mp.
  97. Belize\*.mp.
  98. Bosnia\*.mp.
  99. Herzegovin\*.mp.
  100. Botswana.mp.
  101. Batswana.mp.
  102. Brazil\*.mp.
  103. Bulgaria\*.mp.
  104. Chin\*.mp.
  105. Colombbia\*.mp.
  106. Costa Rica\*.mp.
  107. Cuba\*.mp.
  108. Dominica\*.mp.
  109. Ecuador\*.mp.
  110. Fiji\*.mp.
  111. Gabon\*.mp.
  112. Grenad\*.mp.
  113. Iran\*.mp.
  114. Iraq\*.mp.
  115. Jamaica\*.mp.
  116. Jordan\*.mp.
  117. Kazakh\*.mp.
  118. Leban\*.mp.
  119. Libya\*.mp.
  120. Macedonia\*.mp.
  121. Malaysia\*.mp.
  122. Maldiv\*.mp.
  123. Marshall Island\*.mp.
  124. Mauriti\*.mp.
  125. Mexic\*.mp.
  126. Mongolia\*.mp.
  127. Montenegr\*.mp.
  128. Namibia\*.mp.
  129. Palau\*.mp.
  130. Panama\*.mp.
  131. Paraguay\*.mp.
  132. Peru\*.mp.
  133. Romania\*.mp.
  134. Serbia\*.mp.
  135. South Africa\*.mp.
  136. St Lucia\*.mp.
  137. (St Vincent and the Grenadines).mp.
  138. Vincentian.mp.
  139. Suriname\*.mp.
  140. Thai\*.mp.
  141. Tonga\*.mp.
  142. Tunisia\*.mp.
  143. Turk\*.mp.
  144. Tuvalu\*.mp.
- NCD/CVD Group (Intervention)**
1. Diabet\*.tw.
  2. Obes\*.tw.
  3. Overweight.tw.
  4. Cardiovascular Disease\*.tw.
  5. Hypertens\*.tw.
  6. Non-communicable Disease\*.tw.
  7. Chronic Disease\*.tw.
  8. NCD.tw.
  9. CVD.tw.
  10. Coronary Heart Disease\*.tw.
  11. Cerebrovascular disease\*.tw.
  12. Peripheral arter\* disease\*.tw.
  13. Rheumatic Heart disease\*.tw.

- 14. Congenital heart disease\*.tw.
- 15. Deep vein thrombosis.tw.
- 16. Deep venous thrombosis.tw.
- 17. Pulmonary embol\*.tw.
- 18. Unhealthy diet.tw.
- 19. Physical inactivity.tw.
- 20. Sedentary lifestyle\*.tw.
- 21. Tobacco.tw.
- 22. Alcohol.tw.
- 23. Hypercholesterol?emia.tw.
- 24. Hyperlipid?emia.tw.

**Training Programs Group (Intervention)**

- 1. ((education\* or train\*) adj2 program\*).tw.

Medical Subject Headings (MeSH) terms used for each database:

Medline

**CHW Group (Population)**

- 26. Community health workers/
- 27. Home health aides/
- 28. Community health services/

**LMIC Group (Population)**

- 145. Developing Countries/
- 146. Asia, Southeastern/
- 147. exp "Africa South of the Sahara"/
- 148. "Democratic People's Republic of Korea"/
- 149. exp Micronesia/

**NCD/CVD Group (Intervention)**

- 25. Chronic Disease/
- 26. Diabetes Mellitus/
- 27. exp Diabetes Mellitus, Type 2/
- 28. exp Obesity/
- 29. Overweight/
- 30. Cardiovascular Diseases/
- 31. exp Heart Diseases/
- 32. exp Vascular Diseases/
- 33. Diet, High-Fat/
- 34. Diet, Western/
- 35. Diet/
- 36. exp "Tobacco Use"/
- 37. exp "Tobacco Use Cessation"/
- 38. exp lipoproteins, ldl/
- 39. exp lipoproteins, vldl/
- 40. Cholesterol, Dietary/

- 41. Hypercholesterolemia/
- 42. Hyperlipidemias/
- 43. exp Obesity/
- 44. Overweight/
- 45. Prediabetic state/
- 46. Sedentary Lifestyle/
- 47. exp Drinking Behavior/
- 48. exp Cerebrovascular Disorders/
- 49. Rheumatic Heart Disease/
- 50. exp Heart Defects, Congenital/

**Training Programs Group (Intervention)**

- 2. "early intervention (education)"/
- 3. health education/
- 4. Education/
- 5. Education, Nonprofessional/
- 6. Program Evaluation/

Global Health

**CHW Group (Population)**

- 26. community health services/
- 27. medical auxiliaries/
- 28. health care workers/
- 29. traditional health services/"C
- 30. traditional birth attendants/

**LMIC Group (Population)**

- 145. developing countries/
- 146. south east asia/
- 147. exp indochina/
- 148. taiwan/
- 149. "africa south of sahara"/
- 150. korea democratic people's republic/
- 151. sudan/
- 152. exp micronesia/
- 153. exp "federated states of micronesia"/
- 154. least developed countries/

**NCD/CVD Group (Intervention)**

- 25. chronic diseases/
- 26. exp diabetes/
- 27. type 2 diabetes/
- 28. obesity/
- 29. obesity hyperglycaemia syndrome/
- 30. overweight/
- 31. exp cardiovascular diseases/
- 32. exp hypertension/
- 33. thrombosis/
- 34. exp heart diseases/
- 35. exp vascular diseases/

36. diet/
37. physical activity/
38. exp tobacco/
39. tobacco smoking/
40. exp smoking cessation/
41. alcohol intake/
42. hyperlipaemia/
43. hypercholesterolaemia/
44. cholesterol/

#### **Training Programs Group (Intervention)**

2. education/
3. program development/
4. Program effectiveness/
5. Program evaluation/
6. education programmes/
7. health education/
8. medical education/
9. professional education/
10. training/
11. training courses/
12. training officers/

#### **ERIC**

#### **CHW Group (Population)**

26. community health services/
27. home health aides/
28. home programs/
29. exp Paraprofessional Personnel/
30. Lay people/

#### **LMIC Group (Population)**

145. developing nations/

#### **NCD/CVD Group (Intervention)**

25. chronic illness/
26. diabetes/
27. exp body weight/
28. hypertension/
29. exp Physical Activity Level/
30. physical fitness/
31. exp smoking/
32. exp alcohol abuse/
33. eating habits/

#### **Training Programs Group (Intervention)**

2. caregiver training/
3. volunteer training/
4. health education/
5. nonformal education/

6. exp job training/
7. professional training/
8. "Institutes (Training Programs)"/
9. Professional development/
10. Professional education/
11. teaching methods/
12. health promotion/
13. exp formative evaluation/
14. program development/
15. program improvement/
16. summative evaluation/
17. Program Evaluation/
18. program effectiveness/
19. Duplication/
20. Programs/
21. Program validation/
22. Outcome measures/
23. "Outcomes of education"/
24. Pretests posttests/
25. Educational assessment/
26. Educational quality/
27. "replication (evaluation)"/
28. program guides/
29. program implementation/
30. program design/
31. Programmed Instructional Materials/
32. exp Instructional Materials/
33. material development/
34. Instructional Material evaluation/
35. exp training methods/
36. training/
37. trainers/

#### **Embase**

#### **CHW Group (Population)**

26. exp Health Auxiliary/
27. Health educator/
28. Diabetes educator/
29. exp Health care manpower/
30. Health care personnel
31. exp Traditional birth attendant/

#### **LMIC Group (Population)**

145. exp Lowest income group/
146. exp Developing country/
147. exp Africa South of the Sahara/
148. exp Southeast Asia

#### **NCD/CVD Group (Intervention)**

25. exp Cardiovascular disease/



- 26. exp Non communicable disease/
- 27. exp Chronic disease/
- 28. exp Diabetes Mellitus/
- 29. exp Hypertension/
- 30. exp Obesity/
- 31. exp hyperglycemia/
- 32. Weight gain/
- 33. Diet/
- 34. Western Diet/
- 35. exp Hyperlipidemia/
- 36. Alcohol consumption/
- 37. "tobacco use"/
- 38. tobacco dependence/
- 39. physical inactivity

**Training Programs Group (Intervention)**

- 2. exp Health program/
- 3. exp Education/
- 4. exp Accreditation/
- 5. exp Health education/
- 6. exp Medical education/
- 7. exp Teaching/
- 8. exp Staff training/
- 9. exp Training/
- 10. exp Program evaluation/

CINAHL

**CHW Group (Population)**

- 26. Community Health Worker
- 27. Lay Midwives
- 28. Community Health Services

**LMIC Group (Population)**

- 145. Developing Countries
- 146. Africa South of the Sahara
- 147. Asia, Southeastern

**NCD/CVD Group (Intervention)**

- 25. Alcohol Drinking+
- 26. Cardiovascular Diseases+
- 27. Cardiovascular Risk Factors
- 28. Cerebrovascular Disorders+
- 29. Chronic Disease
- 30. Diabetes Mellitus
- 31. Diabetes Mellitus, Type 2
- 32. Diet
- 33. Diet, Western
- 34. Hyperlipidemia+
- 35. Life Style, Sedentary
- 36. Lipoproteins, LDL+

- 37. Obesity+
- 38. Prediabetic State+
- 39. Smoking Cessation Programs
- 40. Tobacco Products+

**Training Programs Group (Intervention)**

- 2. Education+
- 3. Program Development+
- 4. Quality Assessment+
- 5. Professional Development



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4,5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Yes
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5,6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6,7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ for each meta-analysis).	6,7



PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8-12
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14,15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	13, Figure 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Due to heterogeneity of data, a meta-analysis was not done.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	15
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Not applicable
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16,17
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	17,18
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	18
FUNDING			



## PRISMA 2009 Checklist

Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	19
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From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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For peer review only

# BMJ Open

## The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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Keywords:	Cardiovascular disease, Community Health Worker, Training, Low and Middle Income Countries

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The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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Word count 3904

## Abstract

### Introduction

Community health workers (CHWs) are increasingly being tasked to prevent and manage cardiovascular disease and its risk factors in underserved populations in low and middle income countries (LMIC); however, little is known about the required training necessary for them to accomplish their role. This review aimed to evaluate the training of CHWs for the prevention and management of cardiovascular disease and its risk factors in LMIC.

### Methods

A search strategy was developed in line with PRISMA guidelines and 5 electronic databases (Medline, Global Health, ERIC, EMBASE and CINAHL) were searched to identify peer reviewed studies published till December 2016 on the training of CHWs for prevention or control of cardiovascular disease and its risk factors in LMIC. Study characteristics were extracted using a Microsoft excel spread sheet and quality assessed using Effective Public Health Practice Project's Quality Assessment Tool. The search, data extraction and quality assessment were performed independently by two researchers.

### Results

The search generated 928 articles of which eight were included in the review. One study was a randomised controlled trial, while the remaining were before-after intervention studies. The training methods included classroom lectures, some of which were held at the field site, interactive lessons, e-learning and online support, and group discussions or a mix of two or more. All the studies showed improved knowledge level post-training and two studies demonstrated knowledge retention six months after the intervention.

### Conclusion

This review demonstrates that there is little information about CHW training for CVD prevention and control. The eight studies included in the review indicate that CHWs can be trained effectively for CVD prevention and management, leading to improvement in knowledge, skills and performance. However, well conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and cost-effectiveness of training programs.

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**Strengths and limitations of this study**

- First systematic review to evaluate the effectiveness of training community health workers for the prevention and management of cardiovascular disease and its risk factors in Low and Middle Income Countries.
- The review was conducted in accordance to the PRISMA guidelines.
- Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)’s Quality Assessment Tool.
- Limited number of studies with insufficient data regarding training methods, outcomes and characteristics of CHWs.
- Most of the studies were not controlled, which made it difficult to investigate the effect of potential confounders on the performance of the CHWs.



## INTRODUCTION

### Cardiovascular Diseases in developing countries

Globally, the burden of non-communicable diseases (NCDs) is rising with the cause specific mortality fraction due to NCDs estimated to be 69% in 2030 compared to 59% in 2002.<sup>[1]</sup> This shift is largely driven by a demographic and epidemiologic transition, coupled with rapid urbanization and nutritional transitions in developing countries.<sup>[2]</sup> Currently, cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the developed and developing countries alike, with a greater burden being felt by the latter, as they carry a higher proportion of premature deaths from cardiovascular events.<sup>[3-4]</sup> Most health systems in low- and middle-income countries (LMICs) are unprepared to manage the increasing burden of CVDs as their health systems are often focused on infectious diseases and maternal and child health, rather than chronic diseases.<sup>[5-6]</sup>

### The health workforce for CVD

Access to primary care for CVD prevention and treatment in LMIC can often be challenging<sup>[7]</sup> as these countries have the highest global disease burden and tend to experience some of the greatest shortages in physicians and health workers.<sup>[8]</sup> For example, there are 2.3 health workers per 1000 population in Africa, and 4.3 per 1000 population in South-East Asia.<sup>[9]</sup> A maldistribution of these health workers often exist with a higher concentration of health workers in urban areas compared to rural regions where large proportions of the population resides.<sup>[9-11]</sup> This poor distribution and shortage of health professionals has led some countries to rely on trained community health workers (CHWs), who take on specific tasks for the prevention and management of diseases.

### Community health workers

The World Health Organisation (WHO) defines CHWs as individuals who perform functions related to health-care delivery; have shorter training than professional health workers, are community members, selected by and answerable to the community for their activities and are usually supported by the health system but not necessarily a part of its organization. Typically, they are trained for

specific tasks such as provision of antenatal care or immunisation and often do not hold any formal certifications.<sup>[12]</sup> CHWs have been effective in providing essential health care services in a cost-effective manner.<sup>[13-14]</sup> They have been instrumental in reducing maternal and neonatal mortality rates through their presence in at-home births and making referrals for emergency obstetric care,<sup>[15-17]</sup> and by promoting vaccination uptake, breastfeeding, and education on infectious disease.<sup>[18-19]</sup> More recently, CHWs have been useful in HIV/AIDS prevention and control, educating communities and performing tasks such as testing, counselling and prescribing antiretroviral drugs.<sup>[20-24]</sup> This transfer of responsibilities onto CHWs is commonly referred to as task shifting, which is common in regions with limited access to physicians.<sup>[25-27]</sup> This increase in responsibility has been noted throughout the global health community, and it is not uncommon for CHWs to hold different titles based on the country where they work or the tasks for which they are responsible (such as non-physician healthcare worker, lay health worker, traditional birth attendant, accredited social health activist, Barangay Health worker, etc.).<sup>[12]</sup>

Over the last 10 years, CHWs have had an increasing role in CVD prevention and control.<sup>[28-32]</sup> Although research into the effect of CHWs in CVD prevention and control is relatively new, there is emerging evidence which yields promising results.<sup>[33-36]</sup> There is considerable amount of data and manuals available to help train CHWs for management of infectious diseases and maternal and child health in LMIC,<sup>[37-39]</sup> however, there is a lack of evidence based information regarding the content and method to train CHWs for CVD prevention and control.<sup>[40]</sup> Effective training and re-training are essential for the knowledge and skill-set required for good quality performance. This systematic review aims to provide comprehensive insight into CHW training programs for CVD prevention and control, and provides an evidence base for the effectiveness of training programs in the LMIC context.

**METHODS**

A protocol was written to define the inclusion and exclusion criteria and the methods for the review prior to data extraction in accordance to the PRISMA guidelines.<sup>[41]</sup> Five data bases including Medline

via OvidSP, Global Health via OvidSP, ERIC via OvidSP, Embase via OvidSP, and CINAHL via EBSCO were reviewed.

### **Inclusion and exclusion criteria**

The population considered for this systematic review was CHWs in LMICs. Synonyms for CHWs included in the search were taken from the WHO report on CHWs,<sup>[12]</sup> and other terms based on literature reviews.<sup>[42-44]</sup> A medical librarian was consulted to ensure integrity of our search. The review included intervention studies which offered training programs for CHWs in CVD and cardiovascular risk factor prevention (screening, health promotion) or control (monitoring, management). Papers included were specific in what type of training methods were used, i.e. which topics were covered, length and outcomes of the training programs, etc. Studies were limited to CVDs and their modifiable risk factors including high blood pressure, diabetes, dyslipidaemia, alcohol consumption, tobacco use and physical inactivity. A complete list of free text search terms and subject headings are supplied in Appendix 1. The comparator variable for this paper included usual training or before training and the outcome of interest was an improvement in skills and knowledge of CHWs in the prevention and control of CVDs and their risk factors. Types of studies included were pre-post observational studies, and randomised controlled trials published till 31 December, 2016. Papers in all languages were searched and those in a language other than English were translated. If a study was reported in more than one paper, information from all the papers was included in the review, but the study was counted once.

Studies were limited to those which were explicit in specifying what type of training was done and reported pre-post test scores for CHWs. They included countries classified during 2015 as low-, lower-middle, and upper-middle income countries in the World Bank's Income Classifications.<sup>[45]</sup>

### **Data collection**

After agreeing on the search strategy to be used, two authors (BP, MA) reviewed the literature and extracted the data independently. The number of studies included at each stage of literature search was agreed upon between the two authors to ensure no papers were missed and discrepancies were dealt by consensus. (Figure 1) Data was collected on a pre-specified excel sheet after approval of all reviewers, with variables clearly outlined. The first paper to be included was extracted independently then the data was compared between authors to confirm what was to be expected to report for each variable. This sheet was modified to include all information that was important as data extraction continued. Weekly meetings were held between the data extractors to discuss any disagreements about the inclusion of a paper. If any disagreements, a third author (RJ) was asked to adjudicate. At the end of data extraction, all reviewers met to note any discrepancies and agree on the final data extraction. The references of all the included papers were checked for additional relevant papers. When necessary, corresponding authors of included papers were contacted regarding missing information in the published papers. Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)'s Quality Assessment Tool.<sup>[46]</sup> The Tool provides an overall methodological rating of the studies of strong, moderate or weak as per six components including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts. Studies were rated strong if the study population was representative of the target population; had a robust study design such as a randomised controlled trial; controlled for confounding, used validated data collection tools, and had a low drop-out rate of the study participants. Two authors (BP, MA) followed the quality assessment tool and rated the studies independently and discussed discrepancies by consensus. No study was excluded based on the quality assessment.

To demonstrate the change in knowledge and skills among CHWs, pre- and post-test scores and post intervention scores, published in the eight papers were used to evaluate the effectiveness of training. No additional statistical analysis was done as individual test scores were not available and scores were not standardised across the eight studies. Themes from the qualitative data reported were used to assess the CHWs perception and experience of the training. A meta-analysis was not performed due to heterogeneity of the studies.

## RESULTS

### Characteristics of included studies, CHWs and trainers

The initial search yielded 928 citations published between the period of 1959 and 2016. After removing duplicates 858 titles and 187 abstracts were screened. Ninety studies were assessed for a full-review, of which eight studies were included. Figure 1 outlines the systematic review process. The selected studies were conducted between the year 2000 and 2013, and published between the year 2007 and 2015. Four of the studies were conducted in rural or semi-urban areas and four studies did not mention details about the study site.<sup>[47-50]</sup> None of the studies discussed the cost of training involved or the cost-effectiveness of the training.

The studies included Community Health Workers from Bangladesh, Guatemala, Mexico, South Africa<sup>[51]</sup> and Thailand,<sup>[52]</sup> Community Health Agents from Brazil,<sup>[48]</sup> Cadres Posbindu and Community Health Centre staff from Indonesia,<sup>[49]</sup> Barangay Health Workers from the Philippines,<sup>[53]</sup> Lady Health Workers from Pakistan<sup>[54]</sup> and Healthcare Volunteers from Iran<sup>[50]</sup> and Thailand.<sup>[47]</sup> The number of trained health workers varied from 35<sup>[52]</sup> to 299<sup>[54]</sup> and were mostly women (75-100%). The education of CHWs varied from primary school<sup>[47 53]</sup> to Master Degree holders.<sup>[51 52]</sup> In most studies, the health workers were part of the health system receiving a salary, except in Guatemala where a monthly incentive was provided<sup>[51]</sup> and Iran and Thailand, where CHWs were volunteers from the community.<sup>[47 50]</sup> The training team included health professionals,<sup>[51]</sup> project officers<sup>[54]</sup> and researchers.<sup>[48]</sup> Four studies did not provide details about the trainers.<sup>[47 49 50 52]</sup> Detailed characteristics of the CHWs and trainers are provided in Table 1.

**Table1: Characteristics of Community Health Workers and Trainers**

Study	Type of Health workers (Country of study)	Number of CHWs	Sex	Age	Education	Relation to health system	Trainers
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Community Health Worker (Bangladesh, Guatemala, Mexico & South Africa)	64	84% Females	Not reported	B: Secondary to Master's Degree, G: Secondary, M: Secondary, SA: Secondary	B: NGO employed G: NGO employed M: Government employed SA: NGO employed	Health professionals: physicians, nurses, and nutritionists
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Community Health Agents (Brazil)	37	90.9% Females	50% of CHWs were up to 40 years	Secondary (67.3%)	Government employed	Researchers
Fatmah F, 2014 <sup>[49]</sup>	Cadres Posbindu and Community Health centre staff (Indonesia)	45	100% Females	Mean age 43.3	Primary (26.7%) Secondary (46.7%) Diploma (26.7%)	Government employed	Not reported
Ku GM V et al, 2014 <sup>[53]</sup>	Barangay Health Worker (Philippines)	87	Not reported	Not reported	Primary (8%), Secondary (42%), University (50%)	Government employed	Principal investigators and trained nurses
Nishtar S et al, 2007 <sup>[54]</sup>	Lady Health Worker (Pakistan)	299	100% Females	Not reported	Not reported	Government employed	Heartfile Officer (project officer)
Sangprasert P, 2011 <sup>[47]</sup>	Healthcare Volunteer (Thailand)	75	75% Females	Mean age 49.5	Primary (56.4%), Secondary (30.1%), Diploma (9.7%), University (3.8%)	Volunteers	Not reported
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health Volunteer (Iran)	80	100% Females	Not reported	Primary (39.0%) Secondary (48.1%) University (12.2%)	Volunteers	Not reported
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Community Health Care Worker (Thailand)	35	97% Females	25-34y – (17%), 35-44y – (63%), 45-54y – (20%)	Diploma (5.7%), University (88.6%), Master's (5.7%)	Government employed	Not reported

Note: B (Bangladesh) / G (Guatemala) / M (Mexico) / SA (South Africa)  
NGO (Non-governmental organization)

### Details regarding training methods

Studies used different approaches to develop the curriculum and disseminate knowledge. Training methods included interactive modes like problem-based learning, classroom discussions, demonstrations, media presentations, role-plays, as well as self-training quizzes and assignments, which were either online<sup>[52]</sup> or paper based.<sup>[51]</sup> Training designs included the T5 instructional learning design (Tasks, tutorials, tools, topics, and teamwork) allowing interactive learning,<sup>[55]</sup> or adapting existing education and training materials available from high income countries.<sup>[51]</sup> In one of the studies, CHWs were trained alongside nurses on hypertension, its treatment and its burden through interactive classes.<sup>[48]</sup> The training varied, from 2.5 hours<sup>[50]</sup> up to 40 hours<sup>[52]</sup> over a four to six month period. (Table 2) Training took place at the local health units in four studies<sup>[48 50 52 54]</sup> while the other three studies did not mention details about the training site. Training focused on CVD and its risk factors, healthy lifestyle and dietary habits and physical activity. Four of the studies<sup>[47 51-53]</sup> trained CHWs on anthropometric measurement skills and their interpretation and one study trained CHWs to use a BMI (Body Mass Index) metric tool for nutritional status assessment of the elderly.<sup>[49]</sup> None of the studies made their training materials publicly available. Please see Table 3 for details about training content of each study.

**Table 2: Training methods and duration for CVD and its risk factors management for CHWs in LMICs**

Study	Training details	Duration of training program	Methods of training (workshop, online)
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Non-invasive screening of cardiovascular risk score	Hours of training not reported (2 weeks training over 4 months)	Lectures and interactive lessons. On-site training for anthropometric measurements, BMI and CVD risk score calculation
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Hypertension knowledge and basic skills practices development	16.5 hours (11 sessions fortnightly over 6 months)	Lectures and practical sessions
Fatmah F, 2014 <sup>[49]</sup>	Obesity and hypertension knowledge BMI metric tool measurements	11 hours (2 days)	Lectures and interactive sessions. On-site training for BMI metric tool measurements.
Ku GM V et al, 2014 <sup>[53]</sup>	Diabetes knowledge and basic skills practices development	32 hours	Lectures, two-way demonstrations, hands-on workshops
Nishtar S et al, 2007 <sup>[54]</sup>	Cardiovascular disease prevention	6 hours	Interactive training workshops
Sangprasert P, 2011 <sup>[47]</sup>	Hypertension knowledge and basic skills practices development	Not reported	Lectures and group discussions
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health education about physical activity	2.5 hours (3 weekly sessions)	Lectures, group discussions
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Hypertension knowledge and basic skills practices development	40 hours (16 sessions, over 4 months)	Lectures and group discussion, problem-based learning e-learning and online support Community-based application Assignments and self-evaluations



**Table 3: Training content for CVD and its risk factors management for CHWs in LMICs**

	Knowledge	Skills
<b>Abrahams-Gessel S et al, 2015<sup>[51]</sup></b>	Cardiovascular disease and its risk factors	Blood pressure measurement Weight and height measurements and BMI calculation Obtaining a 5-year CVD risk score using a "Risk scoring Chart"
<b>Da Silva SSB E et al, 2010<sup>[48]</sup></b>	Hypertension and its treatment, Epidemiological data regarding hypertension to clarify its problem, Healthy lifestyle promotion, Treatment adherence and its importance	N/A
<b>Fatmah F, 2014<sup>[49]</sup></b>	Obesity risk factors and consequences Balanced Nutrition and Salt restriction Physical activity for the elderly Hypertension and its risk factors	BMI meter tool measurements for nutritional status assessment
<b>Ku GM V et al, 2014<sup>[53]</sup></b>	Diabetes diagnosis and management Foot care Diabetic diet and dietary counselling Physical activity	Anthropometric measurements (weight, height, waist and hip circumference), BMI and waist-hip ratio calculation and their interpretation. Blood pressure and blood glucose measurement, Psychosocial skills development (active listening, patient and family empowerment and social mobilization)
<b>Nishtar S et al, 2007<sup>[54]</sup></b>	Blood pressure measurement importance and desired frequency, Healthy life style and its role in preventing CVD and its complications	N/A
<b>Sangprasert P, 2011<sup>[47]</sup></b>	Health promotion and health education practices Healthy dietary habits Physical activity Relaxation skills	Blood pressure measurement Weight, height and waist and hip circumference measurements BMI calculation and its interpretation
<b>Seyed Emami R et al, 2011<sup>[50]</sup></b>	Food and nutrition Healthy eating and physical activity Current challenges for physical activity Overcoming barriers for a healthy lifestyle adoption	N/A
<b>Sranacharoenpong K et al, 2012<sup>[52]</sup></b>	Healthy dietary habits and providing proper dietary recommendations Physical activity and motivating at-risk population	Weight, height and waist circumference measurements and their interpretation

**Impact of the training on knowledge and skills**

All the studies assessed the knowledge<sup>[47-54]</sup> and five of them assessed knowledge and skills<sup>[47 49 51-53]</sup> before and after the training sessions. In addition, two studies evaluated the effect of training at 3-6 months<sup>[51]</sup> and 8 months after the intervention study.<sup>[52]</sup> Pre- and post-training mean scores were reported by all studies as a measure of effectiveness of training. Of the eight studies included in the review, we could use scores from seven studies; the eighth study<sup>[47]</sup> could not be included in the figure as the measure of test scores was not described. All the studies showed increase in the knowledge mean scores among CHWs pre- and post-training ranging from 3%<sup>[48]</sup> to 40%,<sup>[51]</sup> with six of the studies reporting statistically significant difference between the base knowledge level and post-training knowledge level of the CHWs.<sup>[47 49 50 52-54]</sup> In the two studies (including five sites) which assessed the knowledge post-intervention, the knowledge level of CHWs in Bangladesh did not change, the CHWs in Guatemala<sup>[51]</sup> showed an average increase of 11%, and the scores of CHWs in Mexico, South Africa<sup>[51]</sup> and Thailand<sup>[52]</sup> decreased over time. Figure 2 provides details regarding the change of the test scores and reported statistical significance of the pre-post training knowledge scores. One study assessed the counselling skills of the participant CHWs at base-line, one month and two-months post-training through field visits.<sup>[49]</sup> In addition, two projects used qualitative methods to assess the potential challenges and enablers of CHW training programs, through observation, interviews, and focus group discussions.<sup>[51 56 57]</sup> CHWs preferred a minimum 2-week training program with interactive classes. Since this was the first time many CHWs were offered training in such a setting, it wasn't clear to them what to expect from the training session or workshops. Language barrier was another challenge, as the training manual was written in the local language, while the medium of instruction was in English, this made it difficult for the CHWs to link the manual with the verbal instructions provided. Barriers experienced while working in the field included gender issues such as taking anthropometric measurements of the opposite sex, lack of trust among community to share their health concerns with CHWs, safety and other cultural issues.<sup>[58]</sup> In addition, heavy workload, underestimation of the time required to carry out the work and low remuneration provided were other barriers raised by CHWs. In terms of frequency of access to learning materials and

satisfaction with the training program (including length, methods, and usefulness of the program, computer skills and using electronic and paper-based materials), CHWs seemed satisfied with the content of training program, and the assignments. However, about 46% did not feel that computer skills were easy to learn.

### Study quality

One out of the eight studies was a randomised controlled trial,<sup>[52]</sup> while the others were pre- and post-observational studies. The CHW retention rates varied across the studies from 77%<sup>[51]</sup> to 88%<sup>[53]</sup> with two studies retaining 100% of CHWs,<sup>[48 52]</sup> and one study not reporting CHW turnover during the study period.<sup>[47]</sup> Detailed information about CHWs,<sup>[54]</sup> trainers,<sup>[47 52]</sup> development of the training program<sup>[48 54]</sup> and process of knowledge evaluation<sup>[54]</sup> was not reported in some studies. The quality of all included studies was assessed using Effective Public Health Practice Project's (EPHPP) Quality Assessment Tool.<sup>[46]</sup> Evaluated across six quality domains, each study was assessed with the potential of an overall rating of weak, moderate or strong. The quality of two studies were rated moderate.<sup>[50 52]</sup> The others were rated weak. Please see Table 4 for details of the quality assessment for each of the six quality domains.

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**Table 4: Assessment of the quality of included studies using the EPHPP tool<sup>[46]</sup>**

Study	Selection bias*1	Study Design*2	Confounders*3	Blinding*4	Data Collection Methods*5	Withdrawals and Drop-outs*6	Overall Rating
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Weak	Moderate	Weak	Weak	Moderate	Weak	<b>Weak</b>
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Moderate	Moderate	Moderate	Weak	Weak	Moderate	<b>Weak</b>
Fatmah F, 2014 <sup>[49]</sup>	Moderate	Weak	Weak	Weak	Moderate	Weak	<b>Weak</b>
Ku GM V et al, 2014 <sup>[53]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Strong	<b>Weak</b>
Nishtar S et al, 2007 <sup>[54]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Weak	<b>Weak</b>
Sangprasert P, 2011 <sup>[47]</sup>	Moderate	Moderate	Moderate	Weak	Moderate	Weak	<b>Weak</b>
Seyed Emami R et al, 2011 <sup>[50]</sup>	Strong	Weak	Strong	Weak	Strong	Moderate	<b>Moderate</b>
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Strong	Strong	Moderate	Weak	Strong	Strong	<b>Moderate</b>

1. Likelihood of the participants to be representing the target population.  
2. The likelihood of bias due to allocation process in the study design.  
3. Effect of variables associated with the intervention and causally related to the outcome of interest.  
4. Likelihood of protection against reporting bias.  
5. Reliability and validity of outcome measures.  
6. Assessment of the description of numbers and reasons for withdrawals and drop-outs.

## DISCUSSION

In this review, we assessed the effectiveness of training CHWs for the prevention and management of CVD and its risk factors. We reviewed eight studies, which focussed on CVD, hypertension, diabetes or physical activity. The limited evidence available from this review demonstrates that CHWs with low-levels of formal education can be trained effectively for CVD and risk factor prevention and management. The knowledge and skill-set of CHWs improved in the immediate post training period for all studies and varied in performance in the 6-8 months after the initiation of the intervention. The limited qualitative data from two studies<sup>[51 56 57]</sup> indicates that interactive training, hands-on workshops and case scenarios were preferred over traditional didactic training. Training sessions adapted to local culture and delivered in the local language were found to be easier for the CHWs to understand and retain. Since measurement of cardiovascular risk factors involves taking blood pressure, height, weight and waist measurements in both men and women, understanding the cultural norms was an essential component to deliver the training to CHWs who were women in most studies.

The studies that measured knowledge at 6-8 months post-training showed variable results, with the majority of CHWs showing a decline in their scores. Further research is needed to assess the ideal interval for re-training to ensure long term improvement in knowledge and consequent improvement in health outcomes for the community. A review of CHW training for maternal and child health related conditions<sup>[59]</sup> and mental health<sup>[60]</sup> found that without re-training, acquired skills and knowledge are lost over time. Different time intervals of refresher training were found to be effective to retain the capability and performance of CHWs. Various studies conducted in different countries had diverse experiences using monthly, quarterly and yearly refresher trainings to help CHWs maintain consistent performance<sup>[59]</sup>. While training is an important determinant of performance, other factors related to training include recognition of competence in skills to perform related tasks. Hence, contemporary CHW training programs now include competency based training rather than the traditional knowledge based training. Recent reviews on task-shifting from physicians to non-physicians for management of CVD and other NCDs in LMIC have found that training, close supervision and feedback are essential for the success of task-shifting interventions.<sup>[25 61]</sup> Training of

CHWs occurs through formal schooling, in-service training and on-the-job experience; and these, coupled with the working environment, supervision, motivation, career growth, and incentives determine the long term effectiveness and performance of CHWs,<sup>[62]</sup> which ultimately impacts on the health of individuals in the community.

Over the last ten years, there have been several studies involving CHWs for the prevention and management of CVD risk factors via complex multifaceted interventions in LMICs.<sup>[63 64]</sup> While most studies that involve CHWs include a component of training, none of them report the content, length or effectiveness of training on CHWs. Studies from South Africa,<sup>[65 66]</sup> Pakistan,<sup>[67]</sup> India,<sup>[68-70]</sup> China,<sup>[71]</sup> Dominic Republic,<sup>[72]</sup> Guatemala,<sup>[73]</sup> Thailand,<sup>[74]</sup> Mexico<sup>[75]</sup> and the Mexican-US border<sup>[76]</sup> have shown innovative ways of involving CHWs for the prevention and control of CVD and its risk factors. However, these studies did not measure the impact of training on CHW knowledge and skill set.

Testing knowledge and skills via pre- and post-training tests does not necessarily reflect the trainee's competence and successful demonstration of behaviour change or change in capability. Standardized measures need to be considered for quality and efficacy assessment of CHW training programs. Few standardized tools and methods for training evaluation and effectiveness assessment are available<sup>[77-80]</sup> which focus on the short-term and long-term outcomes of the training. Kirkpatrick's Four-Level Training Evaluation Model<sup>[80]</sup> is one such method which is based on evaluating the trainees' reaction to the training program, improvement in knowledge, the degree to which they apply the knowledge, and the long-term outcomes. Kaufman's 5 Levels of Evaluation<sup>[79]</sup> is another standard for evaluating the effectiveness of training which evaluates the training design, materials and resources used and the final outcome on the whole community and the trainee. Using standardized methods of evaluation allows better comparison and interpretation of the data.

Research is needed to understand the training needs; CHW and community requirements for the successful roll out of CHW focused interventions on CVD prevention and control. Randomised

controlled trials involving CHWs should provide details about the CHW characteristics, curriculum development, training provided and impact of the training, and these should ideally be costed. Mixed methods studies would give a better understanding of the challenges involved with implementing training programs for CHWs and provide evidence for best practice. Training design should consider the current roles of the CHWs and how the new skills should complement this role. Training should include demonstration, simulation and on the job supervision to improve confidence of CHWs with their newly learned skills. Communication skills training should focus on changing social norms and behaviours and encouraging the community to work on local fears and myths. CHW attitudes, expression of respect, responsibility and concern should be addressed in training design to assure development of appropriate relationship between the CHWs and the patients and rest of the community.<sup>[81]</sup> With the available mobile conferencing platforms, follow-up training can be provided to many trainees at a time, remotely as well. Training should be provided onsite where CHWs perform their roles, evidence suggest that onsite training tends to cost less and cause less disruption of the routine functioning of health services, compared to offsite training.<sup>[82]</sup> Better training programs alone will not solve the problems related to opportunities for career growth and professional development via continuing education; the chance to move to the next level within the health system would help motive CHWs to stay in the workforce.<sup>[59]</sup> Attention needs to be paid to CHW remuneration and career development as these are noted challenges affecting the retention of trained CHWs in the workforce. Governments should adopt innovative national planning and provide suitable financial and legal support to ensure the sustainability of implemented programs.<sup>[83-86]</sup> Researchers should consider making the tool kits and resources for CVD management publicly available to other researchers and governments.

Even though our search included all the CHW terminologies used by the WHO and recent reviews on CHWs,<sup>[44]</sup> we may have missed some studies. After expanding the search to include all languages and extending the time limit to the end of 2016, our search identified only 8 studies. Most of these studies were not controlled trials, which made it difficult to investigate the effect of potential confounders and did not report details about the demographic details of the CHWs and the trainers. This review

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included CHWs who were part of the health system and those that volunteered their services. We acknowledge that there is a difference between health volunteers and CHWs,<sup>[87]</sup> but since the overall aim of the paper was to evaluate the effectiveness of training programs for CVD and its risk factors. We feel that remuneration does not impact change in knowledge and skill set. Despite these limitations, our review indicates that training CHWs about CVD and its risk factors is plausible in LMICs.

In conclusion, this review demonstrates that there is not much information about CHW training for CVD prevention and control in LMICs. The limited evidence indicates that CHWs can be trained in CVD and risk factor prevention and management and can benefit from refresher training. Well conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and cost-effectiveness of training programs.



### **Ethics approvals**

An ethics committee approval was not required for this paper as it involved secondary analysis of publicly available data.

### **Role of funding agency**

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### **Conflict of Interest**

None declared

### **Author Contributions**

BP drafted the protocol under the supervision of RJ. BP and MA performed the search, extracted the data, and contributed towards the interpretation of the results. MA wrote the first draft. RJ conceived the research question, supervised the review and approved the final version of the manuscript. DP and SA provided critical input towards the manuscript. All the authors reviewed the final draft.

### **Data sharing statement**

All the data is available in the systematic review and supplementary files. No extra data is available

References

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;**3**(11):e442 doi: 10.1371/journal.pmed.0030442[published Online First: Epub Date]].

2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. 1971. Milbank Q 2005;**83**(4):731-57 doi: 10.1111/j.1468-0009.2005.00398.x[published Online First: Epub Date]].

3. Cardiovascular diseases (CVDs). World Health Organization. Fact sheet. Secondary Cardiovascular diseases (CVDs). World Health Organization. Fact sheet 2016. <http://www.who.int/mediacentre/factsheets/fs317/en/>.

4. Celermajer DS, Chow CK, Marijon E, et al. Cardiovascular disease in the developing world: prevalences, patterns, and the potential of early disease detection. Journal of the American College of Cardiology 2012;**60**(14):1207-16 doi: 10.1016/j.jacc.2012.03.074[published Online First: Epub Date]].

5. Maher D, Ford N, Unwin N. Priorities for developing countries in the global response to non-communicable diseases. Global Health 2012;**8**:14 doi: 10.1186/1744-8603-8-14[published Online First: Epub Date]].

6. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. Circulation 1998;**97**(6):596-601

7. Crouse HL, Macias CG, Cruz AT, et al. Utilization of a mobile medical van for delivering pediatric care in the bateys of the Dominican Republic. International Journal of Emergency Medicine 2010;**3** (4):227-32 doi: <http://dx.doi.org/10.1007/s12245-010-0198-4>[published Online First: Epub Date]].

8. Scheffler RM, Liu JX, Kinfu Y, et al. Forecasting the global shortage of physicians: an economic-and needs-based approach. Bulletin of the World Health Organization 2008;**86**(7):516-23B

9. The World Health Report 2006: Working together for health: World Health Organization, 2006.

10. Sharma DC. India still struggles with rural doctor shortages. The Lancet 2015;**386**(10011):2381-82

11. Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. The Lancet 2004;**364**(9449):1984-90

12. Lehmann U, Sanders D. Community health workers: what do we know about them. The state of the evidence on programmes, activities, costs and impact on health outcomes of using community health workers Geneva: World Health Organization 2007:1-42

13. Vaughan K, Kok MC, Witter S, et al. Costs and cost-effectiveness of community health workers: evidence from a literature review. Hum Resour Health 2015;**13**(1):71 doi: 10.1186/s12960-015-0070-y[published Online First: Epub Date]].

14. Neupane D, Kallestrup P, McLachlan CS, et al. Community health workers for non-communicable diseases. Lancet Glob Health 2014;**2**(10):e567 doi: 10.1016/S2214-109X(14)70303-1[published Online First: Epub Date]].

15. Gilmore B, McAuliffe E. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low-and middle-income countries: a systematic review. BMC Public Health 2013;**13**(1):1

16. Tran N, Portela A, de Bernis L, et al. Developing Capacities of Community Health Workers in Sexual and Reproductive. Maternal, Newborn 2014

17. Lawn J, Kerber K. Opportunities for Africa's newborns: practical data policy and programmatic support for newborn care in Africa. 2006

18. Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database Syst Rev 2010(3):CD004015 doi: 10.1002/14651858.CD004015.pub3[published Online First: Epub Date]].

19. Lassi ZS, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. Cochrane Database Syst Rev

- 2015;**3**:CD007754 doi: 10.1002/14651858.CD007754.pub3[published Online First: Epub Date]].
20. Mwai GW, Mburu G, Torpey K, et al. Role and outcomes of community health workers in HIV care in sub-Saharan Africa: a systematic review. *Journal of the International AIDS Society* 2013;**16**(1)
  21. Huicho L, Scherpbier RW, Nkowane AM, et al. How much does quality of child care vary between health workers with differing durations of training? An observational multicountry study. *The Lancet* 2008;**372**(9642):910-16
  22. Hermann K, Van Damme W, Pariyo GW, et al. Community health workers for ART in sub-Saharan Africa: learning from experience—capitalizing on new opportunities. *Human resources for health* 2009;**7**(1):1
  23. Schneider H, Hlophe H, van Rensburg D. Community health workers and the response to HIV/AIDS in South Africa: tensions and prospects. *Health policy and Planning* 2008;**23**(3):179-87
  24. Simon S, Chu K, Frieden M, et al. An integrated approach of community health worker support for HIV/AIDS and TB care in Angonia district, Mozambique. *BMC International Health and Human Rights* 2009;**9**(1):1
  25. Joshi R, Alim M, Kengne AP, et al. Task shifting for non-communicable disease management in low and middle income countries—a systematic review. *PloS one* 2014;**9**(8):e103754
  26. Lehmann U, Van Damme W, Barten F, et al. Task shifting: the answer to the human resources crisis in Africa? *Hum Resour Health* 2009;**7**:49 doi: 10.1186/1478-4491-7-49[published Online First: Epub Date]].
  27. Joshi R, Santo, K., Redfern, K. Task shifting for cardiovascular disease management: What can we learn from other models? *Journal of Cardiology and Therapy* 2014;**1**(5):65-73
  28. Abegunde DO, Shengelia B, Luyten A, et al. Can non-physician health-care workers assess and manage cardiovascular risk in primary care? *Bull World Health Organ* 2007;**85**(6):432-40
  29. Raphael JL, Rueda A, Lion KC, et al. The role of lay health workers in pediatric chronic disease: a systematic review. *Acad Pediatr* 2013;**13**(5):408-20 doi: 10.1016/j.acap.2013.04.015[published Online First: Epub Date]].
  30. Balcazar HG, de Heer HD. Community health workers as partners in the management of non-communicable diseases. *Lancet Glob Health* 2015;**3**(9):e508-9 doi: 10.1016/S2214-109X(15)00142-4[published Online First: Epub Date]].
  31. Mohan V, Deepa M, Pradeepa R, et al. Prevention of diabetes in rural India with a telemedicine intervention. *J Diabetes Sci Technol* 2012;**6**(6):1355-64
  32. Cappuccio FP, Kerry SM, Micah FB, et al. A community programme to reduce salt intake and blood pressure in Ghana [ISRCTN88789643]. *BMC public health* 2006;**6**(1):13
  33. Jafar TH, Islam M, Hatcher J, et al. Community based lifestyle intervention for blood pressure reduction in children and young adults in developing country: cluster randomised controlled trial. *BMJ* 2010;**340**:c2641
  34. Coleman R, Gill G, Wilkinson D. Noncommunicable disease management in resource-poor settings: a primary care model from rural South Africa. *Bull World Health Organ* 1998;**76**(6):633-40
  35. Farzadfar F, Murray CJ, Gakidou E, et al. Effectiveness of diabetes and hypertension management by rural primary health-care workers (Behvarz workers) in Iran: a nationally representative observational study. *Lancet* 2012;**379**(9810):47-54 doi: 10.1016/S0140-6736(11)61349-4[published Online First: Epub Date]].
  36. Alem A, Jacobsson L, Hanlon C. Community-based mental health care in Africa: mental health workers' views. *World Psychiatry* 2008;**7**(1):54-7
  37. Redick C, Dini H. The current state of CHW training programs in Sub-Saharan Africa and South Asia: What we know what we dont know and what we need to do. 2014
  38. Waldman R. Health programming for rebuilding states: a briefing paper. 2007

39. Ryabov I. Cost-effectiveness of Community Health Workers in controlling diabetes epidemic on the U.S.-Mexico border. *Public Health* 2014;**128**(7):636-42 doi: <http://dx.doi.org/10.1016/j.puhe.2014.05.002>[published Online First: Epub Date] | .

40. Pallas SW, Minhas D, Pérez-Escamilla R, et al. Community health workers in low-and middle-income countries: what do we know about scaling up and sustainability? *American journal of public health* 2013;**103**(7):e74-e82

41. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine* 2009;**151**(4):264-69

42. Lariosa T. The role of community health workers in malaria control in the Philippines. *The Southeast Asian journal of tropical medicine and public health* 1991;**23**:30-35

43. Sharma R, Webster P, Bhattacharyya S. Factors affecting the performance of community health workers in India: a multi-stakeholder perspective. *Global health action* 2014;**7**

44. Olaniran A, Smith H, Unkels R, et al. Who is a community health worker?—a systematic review of definitions. *Global health action* 2017;**10**(1):1272223

45. The World Bank. *Country and Lending Groups*, 2016.

46. Thomas H. *Quality assessment tool for quantitative studies*. Effective Public Health Practice Project McMaster University, Toronto 2003

47. Sangprasert P. The effects of a training program for the development of hypertension knowledge and basic skills practice (HKBSP) for Thai community healthcare volunteers. *Siriraj Medical Journal* 2011;**63**(5):163-67

48. Da Silva SSBE, Colosimo FC, Pierin AMG. [The effect of educational interventions on nursing team knowledge about arterial hypertension]. *Revista Da Escola de Enfermagem Da Usp* 2010;**44**(2):488-96

49. Fatmah F. Training Effect on Improving Cadres' Knowledge and Skills of Obesity and Hypertension in Older People. *Makara Journal of Health Research* 2014:49-54

50. Seyed Emami R, Eftekhar Ardebili H, Golestan B. Effect of a health education intervention on physical activity knowledge, attitude and behavior in health volunteers. *Journal of hayat* 2011;**16**(3):48-55

51. Abrahams-Gessel S, Denman, C. A., Montano, C. M., Gaziano, Levitt, N. S., T. A., Levitt, N. S., Masuma Khanam, Puoane, T. An assessment of community health workers' ability to screen for cardiovascular disease risk with a simple, non-invasive risk assessment instrument in Bangladesh, Guatemala, Mexico, and South Africa: an observational study. *Lancet Global Health* 2015;**3**(9):e556-e63 doi: [http://dx.doi.org/10.1016/S2214-109X\(15\)00143-6](http://dx.doi.org/10.1016/S2214-109X(15)00143-6)[published Online First: Epub Date] | .

52. Sranacharoenpong K, Hanning RM. Diabetes prevention education program for community health care workers in Thailand. *Journal of Community Health* 2012;**37** (3):610-18

53. Ku GM V , G K. Integrating chronic care with primary care activities: enriching healthcare staff knowledge and skills and improving glycemic control of a cohort of people with diabetes through the First Line Diabetes Care Project in the Philippines. *Global health action* 2014;**7**(25286)

54. Nishtar S, Badar A, Kamal MU, et al. The Heartfile Lodhran CVD prevention project--end of project evaluation. *Promotion & education* 2007;**14** (1):17-27

55. Salter D, Richards L, Carey T. The 'T5' Design Model: An Instructional Model and Learning Environment to Support the Integration of Online and Campus - Based Courses. *Educational Media International* 2004;**41**(3):207-18

56. Sranacharoenpong K, Hanning RM. Developing a diabetes prevention education programme for community health-care workers in Thailand: formative findings. *Primary Health Care Research & Development* 2011;**12** (4):357-69 doi: <http://dx.doi.org/10.1017/S146342361100020X>[published Online First: Epub Date] | .

57. Sranacharoenpong K, Hanning RM, Sirichakwal PP, et al. Process and outcome evaluation of a diabetes prevention education program for community healthcare workers in Thailand. *Education for health* (Abingdon, England) 2009;**22** (3):335
58. Abrahams-Gessel S, Denman CA, Montano CM, et al. The training and fieldwork experiences of community health workers conducting population-based, noninvasive screening for CVD in LMIC. *Global Heart* 2015;**10**(1):45-54 doi: <http://dx.doi.org/10.1016/j.gheart.2014.12.008>[published Online First: Epub Date]].
59. Bhutta ZA, Lassi ZS, Pariyo G, et al. Global experience of community health workers for delivery of health related millennium development goals: a systematic review, country case studies, and recommendations for integration into national health systems. *Global Health Workforce Alliance* 2010;**1**:249-61
60. Armstrong G, Kermode M, Raja S, et al. A mental health training program for community health workers in India: impact on knowledge and attitudes. *International journal of mental health systems* 2011;**5**(1):17
61. Ogedegbe G, Gyamfi J, Plange-Rhule J, et al. Task shifting interventions for cardiovascular risk reduction in low-income and middle-income countries: a systematic review of randomised controlled trials. *BMJ open* 2014;**4**(10) doi: 10.1136/bmjopen-2014-005983[published Online First: Epub Date]].
62. Rowe AK, de Savigny D, Lanata CF, et al. How can we achieve and maintain high-quality performance of health workers in low-resource settings? *The Lancet*; **366**(9490):1026-35 doi: 10.1016/S0140-6736(05)67028-6[published Online First: Epub Date]].
63. Kamath DY, Xavier D, Gupta R, et al. Rationale and design of a randomized controlled trial evaluating community health worker-based interventions for the secondary prevention of acute coronary syndromes in India (SPREAD). *American Heart Journal* 2014;**168** (5):690-97 doi: <http://dx.doi.org/10.1016/j.ahj.2014.07.029>[published Online First: Epub Date]].
64. van de Vijver S, Oti S, Addo J, et al. Review of community-based interventions for prevention of cardiovascular diseases in low- and middle-income countries. *Ethnicity & Health* 2012;**17**(6):651-76 doi: <http://dx.doi.org/10.1080/13557858.2012.754409>[published Online First: Epub Date]].
65. Surka S, Edirippulige S, Steyn K, et al. Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers. *International Journal of Medical Informatics* 2014;**83**(9):648-54 doi: <http://dx.doi.org/10.1016/j.ijmedinf.2014.06.008>[published Online First: Epub Date]].
66. Botes AS, Majikela-Dlangamandla B, Mash R. The ability of health promoters to deliver group diabetes education in South African primary care. *African Journal of Primary Health Care and Family Medicine* 2013;**5**(1)
67. Khan M, Kamal AK, Islam M, et al. Can Trained Field Community Workers Identify Stroke Using a Stroke Symptom Questionnaire as well as Neurologists?: Adaptation and Validation of a Community Worker Administered Stroke Symptom Questionnaire in a Peri-urban Pakistani Community. *Journal of Stroke and Cerebrovascular Diseases* 2015;**24**(1):91-99
68. Balagopal P, Kamamma N, Patel TG, et al. A community-based participatory diabetes prevention and management intervention in rural India using community health workers. *Diabetes Educ* 2012;**38**(6):822-34 doi: <http://dx.doi.org/10.1177/0145721712459890>[published Online First: Epub Date]].
69. Xavier D, Gupta R, Kamath D, et al. Community health worker-based intervention for adherence to drugs and lifestyle change after acute coronary syndrome: a multicentre, open, randomised controlled trial. *The Lancet Diabetes & Endocrinology*; **4**(3):244-53 doi: 10.1016/S2213-8587(15)00480-5[published Online First: Epub Date]].
70. Joshi R, Chow CK, Raju PK, et al. The Rural Andhra Pradesh Cardiovascular Prevention Study (RAPCAPS): a cluster randomized trial. *Journal of the American College of Cardiology* 2012;**59**(13):1188-96



71. Dongbo F, Hua F, McGowan P, et al. Implementation and quantitative evaluation of chronic disease self-management programme in Shanghai, China: randomized controlled trial. *Bulletin of the World Health Organization* 2003;**81**(3):174-74 1p

72. West-Pollak A, Then EP, Podesta C, et al. Impact of a novel community-based lifestyle intervention program on type 2 diabetes and cardiovascular risk in a resource-poor setting in the Dominican Republic. *International Health* 2014;**6**(2):118-24 doi: <http://dx.doi.org/10.1093/inthealth/ih039>[published Online First: Epub Date]].

73. Micikas M, Foster J, Weis A, et al. A community health worker intervention for diabetes self-management among the Tz'utujil Maya of Guatemala. *Health Promotion Practice* 2015;**16**(4):601-08

74. Saranrittichai K, Senarak W, Promthet S, et al. Health behavior after a multiprofessional intervention and training for ongoing volunteer-based community health programme intervention in the North-East of Thailand: what changed and what not? *Asian Pacific Journal of Cancer Prevention* 2012;**13**(9):4801-05

75. Denman CA, Rosales C, Cornejo E, et al. Evaluation of the community-based chronic disease prevention program Meta Salud in Northern Mexico, 2011-2012. *Preventing Chronic Disease* 2014;**11**:E154 doi: <http://dx.doi.org/10.5888/pcd11.140218>[published Online First: Epub Date]].

76. Cornejo E, Denman CA, Sabo S, et al. Scoping review of community health worker/promotora-based chronic disease primary prevention programs on the US-Mexico border. *alamo colson edu mx* 2011;**8085**

77. Alvarez K, Salas E, Garofano CM. An integrated model of training evaluation and effectiveness. *Human resource development Review* 2004;**3**(4):385-416

78. Wang GG, Wilcox D. Training evaluation: knowing more than is practiced. *Advances in Developing Human Resources* 2006;**8**(4):528-39

79. Kaufman R, Keller JM. Levels of evaluation: beyond Kirkpatrick. *Human Resource Development Quarterly* 1994;**5**(4):371-80

80. Bates R. A critical analysis of evaluation practice: the Kirkpatrick model and the principle of beneficence. *Evaluation and program planning* 2004;**27**(3):341-47

81. Perry H, Crigler L. Developing and strengthening community health worker programs at scale. A reference guide and case studies for program managers and policymakers. 2013

82. Ritchie LMP, Schull MJ, Martiniuk AL, et al. A knowledge translation intervention to improve tuberculosis care and outcomes in Malawi: a pragmatic cluster randomized controlled trial. *Implementation Science* 2015;**10**(1):1

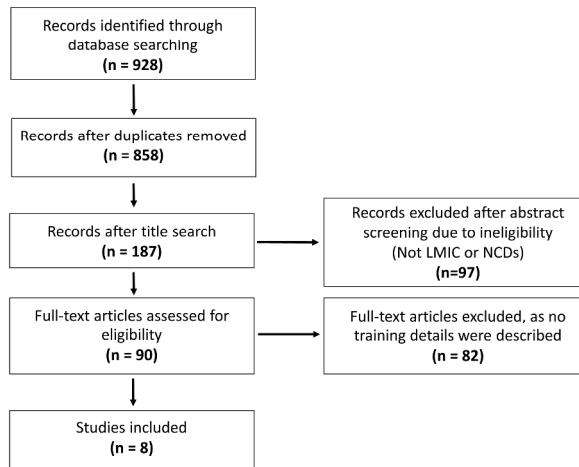
83. Kok MC, Dieleman M, Taegtmeyer M, et al. Which intervention design factors influence performance of community health workers in low-and middle-income countries? A systematic review. *Health policy and planning* 2015;**30**(9):1207-27

84. Abbey M, Bartholomew LK, Nonvignon J, et al. Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana. *International health* 2014;**6**(2):99-105

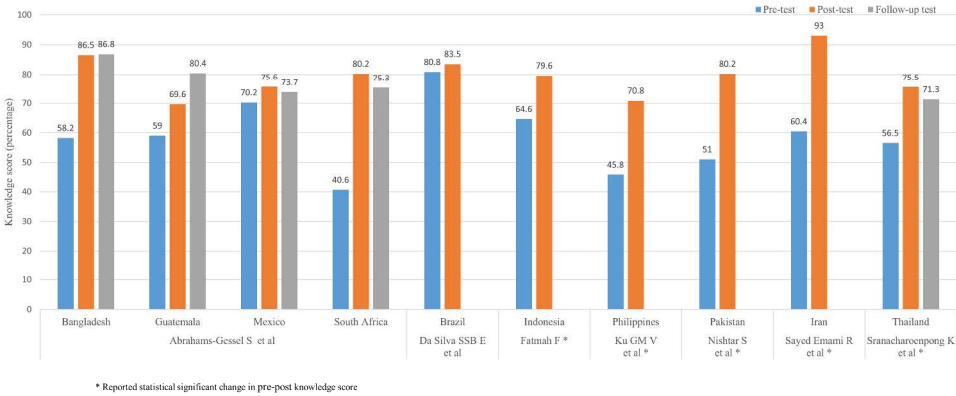
85. Bhattacharyya K, Winch P, LeBan K, et al. Community Health Worker Incentives and Disincentives: How They Affect Motivation, Retention, and Sustainability. Published by the Basic Support for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for International Development. Arlington, Virginia.

86. Research on community-based health workers is needed to achieve the sustainable development goals. *Bulletin of the World Health Organization*. November 2016 ed, 2016:786-86.

87. Vareilles G, Pommier J, Marchal B, et al. Understanding the performance of community health volunteers involved in the delivery of health programmes in underserved areas: a realist synthesis. *Implementation Science* 2017;**12**(1):22



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**APPENDIX 1**

Free text terms used in the databases on the OVID platform (Medline, Global Health, ERIC, Embase):

**CHW Group (Population)**

1. (Communit\* health\* adj3 (work\* or staff or employee\* or provider\* or distributor\* or surveyor\* or assistant\* or promoter\* or facilitator\* or agent\*)).tw.
2. (Non-physician health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
3. CHW.tw.
4. LHW.tw.
5. (Lay health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
6. Volunteer health\* work\*.tw.
7. Voluntary health\* work\*.tw.
8. Promotoras de salud.tw.
9. (rural health adj3 (auxiliar\* or motivator\*)).tw.
10. Traditional midwi\*.tw.
11. TBA.tw.
12. Traditional birth attendant\*.tw.
13. Health\* promoter\*.tw.
14. Basic health\* work\*.tw.
15. Communit\* nutrition work\*.tw.
16. Communit\* resource person.tw.
17. (Female adj3 (multipurpose health\* work\* or volunteer\*)).tw.
18. (Maternal and child health\* work\*).tw.
19. Mother coordinator\*.tw.
20. Outreach educator\*.tw.
21. Paramedic\* work\*.tw.
22. (Village health\* adj3 (work\* or helper\* or guide\*)).tw.
23. Shasthyo Sebikas.tw
24. ASHA.tw
25. Female community health volunteer\*.tw
26. Community-based health worker\*.tw.
27. Beharv\*.tw.
28. Community Care Worker\*.tw.
29. Care Facilitator\*.tw.
30. Community-based reproductive health agents\*.tw.
31. Animatrice de Sante Maternelle\*.tw.
32. Binome de Sante Maternelle\*.tw.

33. Community Health Development Agent\*.tw.
34. Agentes Polivalentes Elementares\*.tw.
35. Community-based Educators\*.tw.
36. Health Extension Worker\*.tw.
37. Health Surveillance Assistant\*.tw.
38. Lay volunteer\*.tw.
39. Shasthyo kormis\*.tw.
40. Community health care practitioners\*.tw.
41. Health assistants\*.tw.
42. Family welfare assistants\*.tw.

**LMIC Group (Population)**

1. LMIC.mp
2. ((Low or middle) adj income countr\*).mp
3. Developing countr\*.mp
4. South East Asia\*.tw
5. Southeast\* Asia\*.mp.
6. Sub-Saharan Africa\*.tw.
7. Sub-Saharan Africa\*.mp.
8. Afghan\*.mp.
9. Benin\*.mp.
10. Burkina\*.mp.
11. Burundi\*.mp.
12. Cambodia\*.mp.
13. Central African Republic\*.mp.
14. Chad\*.mp.
15. Comor\*.mp.
16. Congo\*.mp.
17. Eritrea\*.mp.
18. Ethiopia\*.mp.
19. Gambia\*.mp.
20. Guinea\*.mp.
21. Haiti\*.mp.
22. North Korea\*.mp.
23. Liberia\*.mp.
24. Madagas\*.mp.
25. Malawi\*.mp.
26. Mali\*.mp.
27. Mozambi\*.mp.
28. Nepal\*.mp.
29. Niger\*.mp.
30. Rwanda\*.mp.
31. Sierra Leone\*.mp.
32. Somalia\*.mp.
33. South Sudan\*.mp.
34. Tanzania\*.mp.
35. Togo\*.mp.

36.	Uganda*.mp.	87.	Vietnam*.mp.
37.	Zimbabwe*.mp.	88.	West bank.mp.
38.	Armenia*.mp.	89.	Gaza*.mp.
39.	Bangladesh*.mp.	90.	Yemen*.mp.
40.	Bhutan*.mp.	91.	Zambia*.mp.
41.	Bolivia*.mp.	92.	Albania*.mp.
42.	Cape Verd*.mp.	93.	Algeria*.mp.
43.	Cameroon*.mp.	94.	Angola*.mp.
44.	Cote d'Ivoire.mp.	95.	Azerbaijan*.mp.
45.	Ivorian.mp.	96.	Belarus*.mp.
46.	Djibouti*.mp.	97.	Belize*.mp.
47.	Egypt*.mp.	98.	Bosnia*.mp.
48.	Salvador*.mp.	99.	Herzegovin*.mp.
49.	Georgia*.mp.	100.	Botswana.mp.
50.	Ghana*.mp.	101.	Batswana.mp.
51.	Guatemala*.mp.	102.	Brazil*.mp.
52.	Guyan*.mp.	103.	Bulgaria*.mp.
53.	Hondura*.mp.	104.	Chin*.mp.
54.	India*.mp.	105.	Colombia*.mp.
55.	Indonesia*.mp.	106.	Costa Rica*.mp.
56.	Kenya*.mp.	107.	Cuba*.mp.
57.	Kiribati*.mp.	108.	Dominica*.mp.
58.	Kosov*.mp.	109.	Ecuador*.mp.
59.	Kyrgyz*.mp.	110.	Fiji*.mp.
60.	Lao*.mp.	111.	Gabon*.mp.
61.	Lesotho*.mp.	112.	Grenad*.mp.
62.	Mauritania*.mp.	113.	Iran*.mp.
63.	Micronesia*.mp.	114.	Iraq*.mp.
64.	Moldova*.mp.	115.	Jamaica*.mp.
65.	Morocc*.mp.	116.	Jordan*.mp.
66.	Myanmar*.mp.	117.	Kazakh*.mp.
67.	Burm*.mp.	118.	Leban*.mp.
68.	Nigeria*.mp.	119.	Libya*.mp.
69.	Pakistan*.mp.	120.	Macedonia*.mp.
70.	Nicaragua*.mp.	121.	Malaysia*.mp.
71.	Papua New Guinea*.mp.	122.	Maldiv*.mp.
72.	Philippin*.mp.	123.	Marshall Island*.mp.
73.	Filipino.mp.	124.	Mauriti*.mp.
74.	Samoa*.mp.	125.	Mexic*.mp.
75.	Sao Tome*.mp.	126.	Mongolia*.mp.
76.	Senegal*.mp.	127.	Montenegr*.mp.
77.	Solomon*.mp.	128.	Namibia*.mp.
78.	Sri Lanka*.mp.	129.	Palau*.mp.
79.	Sudan*.mp.	130.	Panama*.mp.
80.	Swazi*.mp.	131.	Paraguay*.mp.
81.	Syria*.mp.	132.	Peru*.mp.
82.	Tajik*.mp.	133.	Romania*.mp.
83.	Timor*.mp.	134.	Serbia*.mp.
84.	Ukrain*.mp.	135.	South Africa*.mp.
85.	Uzbek*.mp.	136.	St Lucia*.mp.
86.	Vanuatu*.mp.	137.	(St Vincent and the Grenadines).mp.

138. Vincentian.mp.
139. Suriname\*.mp.
140. Thai\*.mp.
141. Tonga\*.mp.
142. Tunisia\*.mp.
143. Turk\*.mp.
144. Tuvalu\*.mp.

#### **NCD/CVD Group (Intervention)**

1. Diabet\*.tw.
2. Obes\*.tw.
3. Overweight.tw.
4. Cardiovascular Disease\*.tw.
5. Hypertens\*.tw.
6. Non-communicable Disease\*.tw.
7. Chronic Disease\*.tw.
8. NCD.tw.
9. CVD.tw.
10. Coronary Heart Disease\*.tw.
11. Cerebrovascular disease\*.tw.
12. Peripheral arter\* disease\*.tw.
13. Rheumatic Heart disease\*.tw.
14. Congenital heart disease\*.tw.
15. Deep vein thrombosis.tw.
16. Deep venous thrombosis.tw.
17. Pulmonary embol\*.tw.
18. Unhealthy diet.tw.
19. Physical inactivity.tw.
20. Sedentary lifestyle\*.tw.
21. Tobacco.tw.
22. Alcohol.tw.
23. Hypercholesterol?emia.tw.
24. Hyperlipid?emia.tw.

#### **Training Programs Group (Intervention)**

1. ((education\* or train\*) adj2 program\*).tw.

Medical Subject Headings (MeSH) terms used for each database:

#### Medline

#### **CHW Group (Population)**

26. Community health workers/
27. Home health aides/
28. Community health services/

#### **LMIC Group (Population)**

145. Developing Countries/
146. Asia, Southeastern/

147. exp "Africa South of the Sahara"/
148. "Democratic People's Republic of Korea"/
149. exp Micronesia/

#### **NCD/CVD Group (Intervention)**

25. Chronic Disease/
26. Diabetes Mellitus/
27. exp Diabetes Mellitus, Type 2/
28. exp Obesity/
29. Overweight/
30. Cardiovascular Diseases/
31. exp Heart Diseases/
32. exp Vascular Diseases/
33. Diet, High-Fat/
34. Diet, Western/
35. Diet/
36. exp "Tobacco Use"/
37. exp "Tobacco Use Cessation"/
38. exp lipoproteins, ldl/
39. exp lipoproteins, vldl/
40. Cholesterol, Dietary/
41. Hypercholesterolemia/
42. Hyperlipidemias/
43. exp Obesity/
44. Overweight/
45. Prediabetic state/
46. Sedentary Lifestyle/
47. exp Drinking Behavior/
48. exp Cerebrovascular Disorders/
49. Rheumatic Heart Disease/
50. exp Heart Defects, Congenital/

#### **Training Programs Group (Intervention)**

2. "early intervention (education)"/
3. health education/
4. Education/
5. Education, Nonprofessional/
6. Program Evaluation/

#### Global Health

#### **CHW Group (Population)**

26. community health services/
27. medical auxiliaries/
28. health care workers/
29. traditional health services/"C
30. traditional birth attendants/

#### **LMIC Group (Population)**

145. developing countries/

- 146. south east asia/
- 147. exp indochina/
- 148. taiwan/
- 149. "africa south of sahara"/
- 150. korea democratic people's republic/
- 151. sudan/
- 152. exp micronesia/
- 153. exp "federated states of micronesia"/
- 154. least developed countries/

**NCD/CVD Group (Intervention)**

- 25. chronic diseases/
- 26. exp diabetes/
- 27. type 2 diabetes/
- 28. obesity/
- 29. obesity hyperglycaemia syndrome/
- 30. overweight/
- 31. exp cardiovascular diseases/
- 32. exp hypertension/
- 33. thrombosis/
- 34. exp heart diseases/
- 35. exp vascular diseases/
- 36. diet/
- 37. physical activity/
- 38. exp tobacco/
- 39. tobacco smoking/
- 40. exp smoking cessation/
- 41. alcohol intake/
- 42. hyperlipaemia/
- 43. hypercholesterolaemia/
- 44. cholesterol/

**Training Programs Group (Intervention)**

- 2. education/
- 3. program development/
- 4. Program effectiveness/
- 5. Program evaluation/
- 6. education programmes/
- 7. health education/
- 8. medical education/
- 9. professional education/
- 10. training/
- 11. training courses/
- 12. training officers/

ERIC

**CHW Group (Population)**

- 26. community health services/
- 27. home health aides/
- 28. home programs/

- 29. exp Paraprofessional Personnel/
- 30. Lay people/

**LMIC Group (Population)**

- 145. developing nations/

**NCD/CVD Group (Intervention)**

- 25. chronic illness/
- 26. diabetes/
- 27. exp body weight/
- 28. hypertension/
- 29. exp Physical Activity Level/
- 30. physical fitness/
- 31. exp smoking/
- 32. exp alcohol abuse/
- 33. eating habits/

**Training Programs Group (Intervention)**

- 2. caregiver training/
- 3. volunteer training/
- 4. health education/
- 5. nonformal education/
- 6. exp job training/
- 7. professional training/
- 8. "Institutes (Training Programs)"/
- 9. Professional development/
- 10. Professional education/
- 11. teaching methods/
- 12. health promotion/
- 13. exp formative evaluation/
- 14. program development/
- 15. program improvement/
- 16. summative evaluation/
- 17. Program Evaluation/
- 18. program effectiveness/
- 19. Duplication/
- 20. Programs/
- 21. Program validation/
- 22. Outcome measures/
- 23. "Outcomes of education"/
- 24. Pretests posttests/
- 25. Educational assessment/
- 26. Educational quality/
- 27. "replication (evaluation)"/
- 28. program guides/
- 29. program implementation/
- 30. program design/
- 31. Programmed Instructional Materials/
- 32. exp Instructional Materials/
- 33. material development/
- 34. Instructional Material evaluation/

35. exp training methods/
36. training/
37. trainers/

#### Embase

#### **CHW Group (Population)**

26. exp Health Auxiliary/
27. Health educator/
28. Diabetes educator/
29. exp Health care manpower/
30. Health care personnel
31. exp Traditional birth attendant/

#### **LMIC Group (Population)**

145. exp Lowest income group/
146. exp Developing country/
147. exp Africa South of the Sahara/
148. exp Southeast Asia

#### **NCD/CVD Group (Intervention)**

25. exp Cardiovascular disease/
26. exp Non communicable disease/
27. exp Chronic disease/
28. exp Diabetes Mellitus/
29. exp Hypertension/
30. exp Obesity/
31. exp hyperglycemia/
32. Weight gain/
33. Diet/
34. Western Diet/
35. exp Hyperlipidemia/
36. Alcohol consumption/
37. "tobacco use"/
38. tobacco dependence/
39. physical inactivity

#### **Training Programs Group (Intervention)**

2. exp Health program/
3. exp Education/
4. exp Accreditation/
5. exp Health education/
6. exp Medical education/
7. exp Teaching/
8. exp Staff training/
9. exp Training/
10. exp Program evaluation/

#### CINAHL

#### **CHW Group (Population)**

26. Community Health Worker
27. Lay Midwives
28. Community Health Services

#### **LMIC Group (Population)**

145. Developing Countries
146. Africa South of the Sahara
147. Asia, Southeastern

#### **NCD/CVD Group (Intervention)**

25. Alcohol Drinking+
26. Cardiovascular Diseases+
27. Cardiovascular Risk Factors
28. Cerebrovascular Disorders+
29. Chronic Disease
30. Diabetes Mellitus
31. Diabetes Mellitus, Type 2
32. Diet
33. Diet, Western
34. Hyperlipidemia+
35. Life Style, Sedentary
36. Lipoproteins, LDL+
37. Obesity+
38. Prediabetic State+
39. Smoking Cessation Programs
40. Tobacco Products+

#### **Training Programs Group (Intervention)**

2. Education+
3. Program Development+
4. Quality Assessment+
5. Professional Development



PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4,5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Yes
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5,6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6,7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ for each meta-analysis)	6,7





# PRISMA 2009 Checklist

Page 1 of 2

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8-14
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14,15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11, Figure 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Due to heterogeneity of data, a meta-analysis was not done.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14,15
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Not applicable
<b>DISCUSSION</b>			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16,17,18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18,19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19
<b>FUNDING</b>			



PRISMA 2009 Checklist

Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	20
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From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: [www.prisma-statement.org](http://www.prisma-statement.org).

For peer review only



# BMJ Open

## The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-015529.R2
Article Type:	Research
Date Submitted by the Author:	18-Aug-2017
Complete List of Authors:	Abdel-All, Marwa; The George Institute for Global Health; University of Sydney Putica, Barbara; University of Sydney Praveen, D; The George Institute for Global Health Abimbola, Seye; The George Institute for Global Health; University of Sydney Joshi, Rohina; The George Institute for Global Health; University of Sydney
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Global health, Health policy, Medical education and training, Public health, Patient-centred medicine
Keywords:	Cardiovascular disease, Community Health Worker, Training, Low and Middle Income Countries

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Manuscripts

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The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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## Abstract

### Introduction

Community health workers (CHWs) are increasingly being tasked to prevent and manage cardiovascular disease and its risk factors in underserved populations in low and middle income countries (LMIC); however, little is known about the required training necessary for them to accomplish their role. This review aimed to evaluate the training of CHWs for the prevention and management of cardiovascular disease and its risk factors in LMIC.

### Methods

A search strategy was developed in line with PRISMA guidelines and 5 electronic databases (Medline, Global Health, ERIC, EMBASE and CINAHL) were searched to identify peer reviewed studies published till December 2016 on the training of CHWs for prevention or control of cardiovascular disease and its risk factors in LMIC. Study characteristics were extracted using a Microsoft excel spread sheet and quality assessed using Effective Public Health Practice Project's Quality Assessment Tool. The search, data extraction and quality assessment were performed independently by two researchers.

### Results

The search generated 928 articles of which eight were included in the review. One study was a randomised controlled trial, while the remaining were before-after intervention studies. The training methods included classroom lectures, some of which were held at the field site, interactive lessons, e-learning and online support, and group discussions or a mix of two or more. All the studies showed improved knowledge level post-training and two studies demonstrated knowledge retention six months after the intervention.

### Conclusion

This review demonstrates that there is little information about CHW training for CVD prevention and control. The eight studies included in the review indicate that CHWs can be trained effectively for CVD prevention and management, leading to improvement in knowledge, skills and performance. However, well conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and cost-effectiveness of training programs.

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**Strengths and limitations of this study**

- First systematic review to evaluate the effectiveness of training community health workers for the prevention and management of cardiovascular disease and its risk factors in Low and Middle Income Countries.
- The review was conducted in accordance to the PRISMA guidelines.
- Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)’s Quality Assessment Tool.
- Limited number of studies with insufficient data regarding training methods, outcomes and characteristics of CHWs.
- Most of the studies were not controlled, which made it difficult to investigate the effect of potential confounders on the performance of the CHWs.

## INTRODUCTION

### Cardiovascular Diseases in developing countries

Globally, the burden of non-communicable diseases (NCDs) is rising with the cause specific mortality fraction due to NCDs estimated to be 69% in 2030 compared to 59% in 2002.<sup>[1]</sup> This shift is largely driven by a demographic and epidemiologic transition, coupled with rapid urbanization and nutritional transitions in developing countries.<sup>[2]</sup> Currently, cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the developed and developing countries alike, with a greater burden being felt by the latter, as they carry a higher proportion of premature deaths from cardiovascular events.<sup>[3-4]</sup> Most health systems in low- and middle-income countries (LMICs) are unprepared to manage the increasing burden of CVDs as their health systems are often focused on infectious diseases and maternal and child health, rather than chronic diseases.<sup>[5-6]</sup>

### The health workforce for CVD

Access to primary care for CVD prevention and treatment in LMIC can often be challenging<sup>[7]</sup> as these countries have the highest global disease burden and tend to experience some of the greatest shortages in physicians and health workers.<sup>[8]</sup> For example, there are 2.3 health workers per 1000 population in Africa, and 4.3 per 1000 population in South-East Asia.<sup>[9]</sup> A maldistribution of these health workers often exist with a higher concentration of health workers in urban areas compared to rural regions where large proportions of the population resides.<sup>[9-11]</sup> This poor distribution and shortage of health professionals has led some countries to rely on trained community health workers (CHWs), who take on specific tasks for the prevention and management of diseases.

### Community health workers

The World Health Organisation (WHO) defines CHWs as individuals who perform functions related to health-care delivery; have shorter training than professional health workers, are community members, selected by and answerable to the community for their activities and are usually supported by the health system but not necessarily a part of its organization. Typically, they are trained for

specific tasks such as provision of antenatal care or immunisation and often do not hold any formal certifications.<sup>[12]</sup> CHWs have been effective in providing essential health care services in a cost-effective manner.<sup>[13-14]</sup> They have been instrumental in reducing maternal and neonatal mortality rates through their presence in at-home births and making referrals for emergency obstetric care,<sup>[15-17]</sup> and by promoting vaccination uptake, breastfeeding, and education on infectious disease.<sup>[18-19]</sup> More recently, CHWs have been useful in HIV/AIDS prevention and control, educating communities and performing tasks such as testing, counselling and prescribing antiretroviral drugs.<sup>[20-24]</sup> This transfer of responsibilities onto CHWs is commonly referred to as task shifting, which is common in regions with limited access to physicians.<sup>[25-27]</sup> This increase in responsibility has been noted throughout the global health community, and it is not uncommon for CHWs to hold different titles based on the country where they work or the tasks for which they are responsible (such as non-physician healthcare worker, lay health worker, traditional birth attendant, accredited social health activist, Barangay Health worker, etc.).<sup>[12]</sup>

Over the last 10 years, CHWs have had an increasing role in CVD prevention and control.<sup>[28-32]</sup> Although research into the effect of CHWs in CVD prevention and control is relatively new, there is emerging evidence which yields promising results.<sup>[33-36]</sup> There is considerable amount of data and manuals available to help train CHWs for management of infectious diseases and maternal and child health in LMIC,<sup>[37-39]</sup> however, there is a lack of evidence based information regarding the content and method to train CHWs for CVD prevention and control.<sup>[40]</sup> Effective training and re-training are essential for the knowledge and skill-set required for good quality performance. This systematic review aims to provide comprehensive insight into CHW training programs for CVD prevention and control, and provides an evidence base for the effectiveness of training programs in the LMIC context.

**METHODS**

A protocol was written to define the inclusion and exclusion criteria and the methods for the review prior to data extraction in accordance to the PRISMA guidelines.<sup>[41]</sup> Five data bases including Medline

via OvidSP, Global Health via OvidSP, ERIC via OvidSP, Embase via OvidSP, and CINAHL via EBSCO were reviewed.

### **Inclusion and exclusion criteria**

The population considered for this systematic review was CHWs in LMICs. Synonyms for CHWs included in the search were taken from the WHO report on CHWs,<sup>[12]</sup> and other terms based on literature reviews.<sup>[42-44]</sup> A medical librarian was consulted to ensure integrity of our search. The review included intervention studies which offered training programs for CHWs in CVD and cardiovascular risk factor prevention (screening, health promotion) or control (monitoring, management). Papers included were specific in what type of training methods were used, i.e. which topics were covered, length and outcomes of the training programs, etc. Studies were limited to CVDs and their modifiable risk factors including high blood pressure, diabetes, dyslipidaemia, alcohol consumption, tobacco use and physical inactivity. A complete list of free text search terms and subject headings are supplied in Appendix 1. The comparator variable for this paper included usual training or before training and the outcome of interest was an improvement in skills and knowledge of CHWs in the prevention and control of CVDs and their risk factors. Types of studies included were pre-post observational studies, and randomised controlled trials published till 31 December, 2016. Papers in all languages were searched and those in a language other than English were translated. If a study was reported in more than one paper, information from all the papers was included in the review, but the study was counted once.

Studies were limited to those which were explicit in specifying what type of training was done and reported pre-post test scores for CHWs. They included countries classified during 2015 as low-, lower-middle, and upper-middle income countries in the World Bank's Income Classifications.<sup>[45]</sup>

### **Data collection**

After agreeing on the search strategy to be used, two authors (BP, MA) reviewed the literature and extracted the data independently. The number of studies included at each stage of literature search was agreed upon between the two authors to ensure no papers were missed and discrepancies were dealt by consensus. (Figure 1) Data was collected on a pre-specified excel sheet after approval of all reviewers, with variables clearly outlined. The first paper to be included was extracted independently then the data was compared between authors to confirm what was to be expected to report for each variable. This sheet was modified to include all information that was important as data extraction continued. Weekly meetings were held between the data extractors to discuss any disagreements about the inclusion of a paper. If any disagreements, a third author (RJ) was asked to adjudicate. At the end of data extraction, all reviewers met to note any discrepancies and agree on the final data extraction. The references of all the included papers were checked for additional relevant papers. When necessary, corresponding authors of included papers were contacted regarding missing information in the published papers. Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)'s Quality Assessment Tool.<sup>[46]</sup> The Tool provides an overall methodological rating of the studies of strong, moderate or weak as per six components including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts. Studies were rated strong if the study population was representative of the target population; had a robust study design such as a randomised controlled trial; controlled for confounding, used validated data collection tools, and had a low drop-out rate of the study participants. Two authors (BP, MA) followed the quality assessment tool and rated the studies independently and discussed discrepancies by consensus. No study was excluded based on the quality assessment.

**Data analysis**

To demonstrate the change in knowledge and skills among CHWs, pre- and post-test scores and post intervention scores, published in the eight papers were used to evaluate the effectiveness of training. No additional statistical analysis was done as individual test scores were not available and scores were not standardised across the eight studies. All studies were reviewed and a narrative synthesis was conducted to assess the studies comprehensively. The data were tabulated to explore the relationship



between and within the included studies. Themes from the qualitative data reported were used to assess the CHWs perception and experience of the training. A meta-analysis was not performed due to heterogeneity of the studies.

## RESULTS

### Characteristics of included studies, CHWs and trainers

The initial search yielded 928 citations published between the period of 1959 and 2016. After removing duplicates 858 titles and 187 abstracts were screened. Ninety studies were assessed for a full-review, of which eight studies were included. Figure 1 outlines the systematic review process. The selected studies were conducted between the year 2000 and 2013, and published between the year 2007 and 2015. Four of the studies were conducted in rural or semi-urban areas and four studies did not mention details about the study site.<sup>[47-50]</sup> None of the studies discussed the cost of training involved or the cost-effectiveness of the training.

The studies included Community Health Workers from Bangladesh, Guatemala, Mexico, South Africa<sup>[51]</sup> and Thailand,<sup>[52]</sup> Community Health Agents from Brazil,<sup>[48]</sup> Cadres Posbindu and Community Health Centre staff from Indonesia,<sup>[49]</sup> Barangay Health Workers from the Philippines,<sup>[53]</sup> Lady Health Workers from Pakistan<sup>[54]</sup> and Healthcare Volunteers from Iran<sup>[50]</sup> and Thailand.<sup>[47]</sup> The number of trained health workers varied from 35<sup>[52]</sup> to 299<sup>[54]</sup> and were mostly women (75-100%). The education of CHWs varied from primary school<sup>[47 53]</sup> to Master Degree holders.<sup>[51 52]</sup> In most studies, the health workers were part of the health system receiving a salary, except in Guatemala where a monthly incentive was provided<sup>[51]</sup> and Iran and Thailand, where CHWs were volunteers from the community.<sup>[47 50]</sup> The training team included health professionals,<sup>[51]</sup> project officers<sup>[54]</sup> and researchers.<sup>[48]</sup> Four studies did not provide details about the trainers.<sup>[47 49 50 52]</sup> Detailed characteristics of the CHWs and trainers are provided in Table 1.

**Table1: Characteristics of Community Health Workers and Trainers**

Study	Type of Health workers (Country of study)	Number of CHWs	Sex	Age	Education	Relation to health system	Trainers
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Community Health Worker (Bangladesh, Guatemala, Mexico & South Africa)	64	84% Females	Not reported	B: Secondary to Master's Degree, G: Secondary, M: Secondary, SA: Secondary	B: NGO employed G: NGO employed M: Government employed SA: NGO employed	Health professionals: physicians, nurses, and nutritionists
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Community Health Agents (Brazil)	37	90.9% Females	50% of CHWs were up to 40 years	Secondary (67.3%)	Government employed	Researchers
Fatmah F, 2014 <sup>[49]</sup>	Cadres Posbindu and Community Health centre staff (Indonesia)	45	100% Females	Mean age 43.3	Primary (26.7%) Secondary (46.7%) Diploma (26.7%)	Government employed	Not reported
Ku GM V et al, 2014 <sup>[53]</sup>	Barangay Health Worker (Philippines)	87	Not reported	Not reported	Primary (8%), Secondary (42%), University (50%)	Government employed	Principal investigators and trained nurses
Nishtar S et al, 2007 <sup>[54]</sup>	Lady Health Worker (Pakistan)	299	100% Females	Not reported	Not reported	Government employed	Heartfile Officer (project officer)
Sangprasert P, 2011 <sup>[47]</sup>	Healthcare Volunteer (Thailand)	75	75% Females	Mean age 49.5	Primary (56.4%), Secondary (30.1%), Diploma (9.7%), University (3.8%)	Volunteers	Not reported
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health Volunteer (Iran)	80	100% Females	Not reported	Primary (39.0%) Secondary (48.1%) University (12.2%)	Volunteers	Not reported
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Community Health Care Worker (Thailand)	35	97% Females	25-34y – (17%), 35-44y – (63%), 45-54y – (20%)	Diploma (5.7%), University (88.6%), Master's (5.7%)	Government employed	Not reported

Note: B (Bangladesh) / G (Guatemala) / M (Mexico) / SA (South Africa)  
NGO (Non-governmental organization)

### Details regarding training methods

Studies used different approaches to develop the curriculum and disseminate knowledge. Training methods included interactive modes like problem-based learning, classroom discussions, demonstrations, media presentations, role-plays, as well as self-training quizzes and assignments, which were either online<sup>[52]</sup> or paper based.<sup>[51]</sup> Training designs included the T5 instructional learning design (Tasks, tutorials, tools, topics, and teamwork) allowing interactive learning,<sup>[55]</sup> or adapting existing education and training materials available from high income countries.<sup>[51]</sup> In one of the studies, CHWs were trained alongside nurses on hypertension, its treatment and its burden through interactive classes.<sup>[48]</sup> The training varied, from 2.5 hours<sup>[50]</sup> up to 40 hours<sup>[52]</sup> over a four to six month period. (Table 2) Training took place at the local health units in four studies<sup>[48 50 52 54]</sup> while the other three studies did not mention details about the training site. Training focused on CVD and its risk factors, healthy lifestyle and dietary habits and physical activity. Four of the studies<sup>[47 51-53]</sup> trained CHWs on anthropometric measurement skills and their interpretation and one study trained CHWs to use a BMI (Body Mass Index) metric tool for nutritional status assessment of the elderly.<sup>[49]</sup> None of the studies made their training materials publicly available. Please see Table 3 for details about training content of each study.

**Table 2: Training methods and duration for CVD and its risk factors management for CHWs in LMICs**

Study	Training details	Duration of training program	Methods of training (workshop, online)
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Non-invasive screening of cardiovascular risk score	Hours of training not reported (2 weeks training over 4 months)	Lectures and interactive lessons. On-site training for anthropometric measurements, BMI and CVD risk score calculation
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Hypertension knowledge and basic skills practices development	16.5 hours (11 sessions fortnightly over 6 months)	Lectures and practical sessions
Fatmah F, 2014 <sup>[49]</sup>	Obesity and hypertension knowledge BMI metric tool measurements	11 hours (2 days)	Lectures and interactive sessions. On-site training for BMI metric tool measurements.
Ku GM V et al, 2014 <sup>[53]</sup>	Diabetes knowledge and basic skills practices development	32 hours	Lectures, two-way demonstrations, hands-on workshops
Nishtar S et al, 2007 <sup>[54]</sup>	Cardiovascular disease prevention	6 hours	Interactive training workshops
Sangprasert P, 2011 <sup>[47]</sup>	Hypertension knowledge and basic skills practices development	Not reported	Lectures and group discussions
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health education about physical activity	2.5 hours (3 weekly sessions)	Lectures, group discussions
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Hypertension knowledge and basic skills practices development	40 hours (16 sessions, over 4 months)	Lectures and group discussion, problem-based learning e-learning and online support Community-based application Assignments and self-evaluations

**Table 3: Training content for CVD and its risk factors management for CHWs in LMICs**

	Knowledge	Skills
<b>Abrahams-Gessel S et al, 2015<sup>[51]</sup></b>	Cardiovascular disease and its risk factors	Blood pressure measurement Weight and height measurements and BMI calculation Obtaining a 5-year CVD risk score using a "Risk scoring Chart"
<b>Da Silva SSB E et al, 2010<sup>[48]</sup></b>	Hypertension and its treatment, Epidemiological data regarding hypertension to clarify its problem, Healthy lifestyle promotion, Treatment adherence and its importance	N/A
<b>Fatmah F, 2014<sup>[49]</sup></b>	Obesity risk factors and consequences Balanced Nutrition and Salt restriction Physical activity for the elderly Hypertension and its risk factors	BMI meter tool measurements for nutritional status assessment
<b>Ku GM V et al, 2014<sup>[53]</sup></b>	Diabetes diagnosis and management Foot care Diabetic diet and dietary counselling Physical activity	Anthropometric measurements (weight, height, waist and hip circumference), BMI and waist-hip ratio calculation and their interpretation. Blood pressure and blood glucose measurement, Psychosocial skills development (active listening, patient and family empowerment and social mobilization)
<b>Nishtar S et al, 2007<sup>[54]</sup></b>	Blood pressure measurement importance and desired frequency, Healthy life style and its role in preventing CVD and its complications	N/A
<b>Sangprasert P, 2011<sup>[47]</sup></b>	Health promotion and health education practices Healthy dietary habits Physical activity Relaxation skills	Blood pressure measurement Weight, height and waist and hip circumference measurements BMI calculation and its interpretation
<b>Seyed Emami R et al, 2011<sup>[50]</sup></b>	Food and nutrition Healthy eating and physical activity Current challenges for physical activity Overcoming barriers for a healthy lifestyle adoption	N/A
<b>Sranacharoenpong K et al, 2012<sup>[52]</sup></b>	Healthy dietary habits and providing proper dietary recommendations Physical activity and motivating at-risk population	Weight, height and waist circumference measurements and their interpretation

**Impact of the training on knowledge and skills**

All the studies assessed the knowledge<sup>[47-54]</sup> and five of them assessed knowledge and skills<sup>[47 49 51-53]</sup> before and after the training sessions. In addition, two studies evaluated the effect of training at 3-6 months<sup>[51]</sup> and 8 months after the intervention study.<sup>[52]</sup> Pre- and post-training mean scores were reported by all studies as a measure of effectiveness of training. Of the eight studies included in the review, we could use scores from seven studies; the eighth study<sup>[47]</sup> could not be included in the figure as the measure of test scores was not described. All the studies showed increase in the knowledge mean scores among CHWs pre- and post-training ranging from 3%<sup>[48]</sup> to 40%,<sup>[51]</sup> with six of the studies reporting statistically significant difference between the base knowledge level and post-training knowledge level of the CHWs.<sup>[47 49 50 52-54]</sup> In the two studies (including five sites) which assessed the knowledge post-intervention, the knowledge level of CHWs in Bangladesh did not change, the CHWs in Guatemala<sup>[51]</sup> showed an average increase of 11%, and the scores of CHWs in Mexico, South Africa<sup>[51]</sup> and Thailand<sup>[52]</sup> decreased over time. Figure 2 provides details regarding the change of the test scores and reported statistical significance of the pre-post training knowledge scores. One study assessed the counselling skills of the participant CHWs at base-line, one month and two-months post-training through field visits.<sup>[49]</sup> In addition, two projects used qualitative methods to assess the potential challenges and enablers of CHW training programs, through observation, interviews, and focus group discussions.<sup>[51 56 57]</sup>

CHWs preferred a minimum 2-week training program with interactive classes. Since this was the first time many CHWs were offered training in such a setting, it wasn't clear to them what to expect from the training session or workshops. Language barrier was another challenge, as the training manual was written in the local language, while the medium of instruction was in English, this made it difficult for the CHWs to link the manual with the verbal instructions provided. Barriers experienced while working in the field included gender issues such as taking anthropometric measurements of the opposite sex, lack of trust among community to share their health concerns with CHWs, safety and other cultural issues.<sup>[51 58 59]</sup> In addition, heavy workload, underestimation of the time required to carry out the work and low remuneration provided were other barriers raised by CHWs. In terms of

frequency of access to learning materials and satisfaction with the training program (including length, methods, and usefulness of the program, computer skills and using electronic and paper-based materials), CHWs seemed satisfied with the content of training program, and the assignments. However, about 46% did not feel that computer skills were easy to learn.

### Study quality

One out of the eight studies was a randomised controlled trial,<sup>[52]</sup> while the others were pre- and post-observational studies. The CHW retention rates varied across the studies from 77%<sup>[51]</sup> to 88%<sup>[53]</sup> with two studies retaining 100% of CHWs,<sup>[48 52]</sup> and one study not reporting CHW turnover during the study period.<sup>[47]</sup> Detailed information about CHWs,<sup>[54]</sup> trainers,<sup>[47 52]</sup> development of the training program<sup>[48 54]</sup> and process of knowledge evaluation<sup>[54]</sup> was not reported in some studies. The quality of all included studies was assessed using Effective Public Health Practice Project's (EPHPP) Quality Assessment Tool.<sup>[46]</sup> Evaluated across six quality domains, each study was assessed with the potential of an overall rating of weak, moderate or strong. The quality of two studies were rated moderate.<sup>[50 52]</sup> The others were rated weak. Please see Table 4 for details of the quality assessment for each of the six quality domains.

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**Table 4: Assessment of the quality of included studies using the EPHPP tool<sup>[46]</sup>**

Study	Selection bias*1	Study Design*2	Confounders*3	Blinding*4	Data Collection Methods*5	Withdrawals and Drop-outs*6	Overall Rating
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Weak	Moderate	Weak	Weak	Moderate	Weak	<b>Weak</b>
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Moderate	Moderate	Moderate	Weak	Weak	Moderate	<b>Weak</b>
Fatmah F, 2014 <sup>[49]</sup>	Moderate	Weak	Weak	Weak	Moderate	Weak	<b>Weak</b>
Ku GM V et al, 2014 <sup>[53]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Strong	<b>Weak</b>
Nishtar S et al, 2007 <sup>[54]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Weak	<b>Weak</b>
Sangprasert P, 2011 <sup>[47]</sup>	Moderate	Moderate	Moderate	Weak	Moderate	Weak	<b>Weak</b>
Seyed Emami R et al, 2011 <sup>[50]</sup>	Strong	Weak	Strong	Weak	Strong	Moderate	<b>Moderate</b>
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Strong	Strong	Moderate	Weak	Strong	Strong	<b>Moderate</b>

1. Likelihood of the participants to be representing the target population.  
2. The likelihood of bias due to allocation process in the study design.  
3. Effect of variables associated with the intervention and causally related to the outcome of interest.  
4. Likelihood of protection against reporting bias.  
5. Reliability and validity of outcome measures.  
6. Assessment of the description of numbers and reasons for withdrawals and drop-outs.



## DISCUSSION

In this review, we assessed the effectiveness of training CHWs for the prevention and management of CVD and its risk factors. We reviewed eight studies, which focussed on CVD, hypertension, diabetes or physical activity. The limited evidence available from this review demonstrates that CHWs with low-levels of formal education can be trained effectively for CVD and risk factor prevention and management. The results of this review need to be assessed in light of the study quality which was rated as weak to moderate using the EPHPP tool. The knowledge and skill-set of CHWs improved in the immediate post training period for all studies and varied in performance in the 6-8 months after the initiation of the intervention. The limited qualitative data from two studies<sup>[51 56 57]</sup> indicates that interactive training, hands-on workshops and case scenarios were preferred over traditional didactic training. Training sessions adapted to local culture and delivered in the local language were found to be easier for the CHWs to understand and retain. Since measurement of cardiovascular risk factors involves taking blood pressure, height, weight and waist measurements in both men and women, understanding the cultural norms was an essential component to deliver the training to CHWs who were women in most studies.

Regardless of the baseline knowledge scores of the trained CHWs, most of the post-training knowledge scores ranged between 70 and 80%. The two studies<sup>[51 52]</sup> that measured knowledge at 6-8 months post-training showed that the majority of CHWs had a small decline in their scores; demonstrating their retention of knowledge to certain degree over a period of six to eight months. Further research is needed to assess the ideal interval for re-training to ensure long term improvement in knowledge and consequent improvement in health outcomes for the community. A review of CHW training for maternal and child health related conditions<sup>[60]</sup> and mental health<sup>[61]</sup> found that without re-training, acquired skills and knowledge are lost over time. Different time intervals of refresher training were found to be effective to retain the capability and performance of CHWs. Various studies conducted in different countries had diverse experiences using monthly, quarterly and yearly refresher trainings to help CHWs maintain consistent performance<sup>[60]</sup>. While training is an

important determinant of performance, other factors related to training include recognition of competence in skills to perform related tasks. Hence, contemporary CHW training programs now include competency based training rather than the traditional knowledge based training. Recent reviews on task-shifting from physicians to non-physicians for management of CVD and other NCDs in LMIC have found that training, close supervision and feedback are essential for the success of task-shifting interventions.<sup>[25 62]</sup> Training of CHWs occurs through formal schooling, in-service training and on-the-job experience; and these, coupled with the working environment, supervision, motivation, career progression, and incentives determine the long term effectiveness and performance of CHWs,<sup>[63]</sup> which ultimately impacts the health of individuals in the community.

While the focus of this paper was knowledge change, results from some of these studies have demonstrated the effectiveness of CHW training on health outcomes. For instance, trained CHWs in Bangladesh, Guatemala, Mexico and South Africa could correctly identify individuals at high risk of CVD <sup>[51]</sup>, and CHW screening had high concordance with health professionals. In Indonesia, the Posbindu health workers were successful in motivating the elderly to actively engage with the health care providers and have better access to health care. <sup>[49]</sup> In the Philippines, Barangay health workers trained in diabetes care, were instrumental in improving Glycaemic control among diabetics. <sup>[53]</sup> In Pakistan, trained CHWs were successful in educating communities in cardiovascular risk factors. <sup>[54]</sup>

Over the last ten years, there have been several studies involving CHWs for the prevention and management of CVD risk factors via complex multifaceted interventions in LMICs.<sup>[64 65]</sup> While most studies that involve CHWs include a component of training, none of them report the content, length or effectiveness of training on CHWs. Studies from South Africa,<sup>[66 67]</sup> Pakistan,<sup>[68]</sup> India,<sup>[69-71]</sup> China,<sup>[72]</sup> Dominic Republic,<sup>[73]</sup> Guatemala,<sup>[74]</sup> Thailand,<sup>[75]</sup> Mexico<sup>[76]</sup> and the Mexican-US border<sup>[77]</sup> have shown innovative ways of involving CHWs for the prevention and control of CVD and its risk factors. However, these studies did not measure the impact of training on CHW knowledge and skill set.

Testing knowledge and skills via pre- and post-training tests does not necessarily reflect the trainee's competence and successful demonstration of behaviour change or change in capability. Standardized measures need to be considered for quality and efficacy assessment of CHW training programs. Few standardized tools and methods for training evaluation and effectiveness assessment are available<sup>[78-81]</sup> which focus on the short-term and long-term outcomes of the training. Kirkpatrick's Four-Level Training Evaluation Model<sup>[81]</sup> is one such method which is based on evaluating the trainees' reaction to the training program, improvement in knowledge, the degree to which they apply the knowledge, and the long-term outcomes. Kaufman's 5 Levels of Evaluation<sup>[80]</sup> is another standard for evaluating the effectiveness of training which evaluates the training design, materials and resources used and the final outcome on the whole community and the trainee. Using standardized methods of evaluation allows better comparison and interpretation of the data.

This review was not able to explain the difference in the knowledge gained by CHWs within and across knowledge), and the variability of the training duration and contextual factors. For instance, the knowledge score of the CHWs in South Africa, Guatemala and Bangladesh were higher than the scores of CHWs in Mexico, even though all four sites were part of the same trial with the same training protocol.<sup>[51]</sup> Hence, research is needed to understand the training needs of the; CHWs and community requirements for the successful roll out of CHW focused interventions on CVD prevention and control. Randomised controlled trials involving CHWs should provide details about the CHW characteristics, curriculum development, training provided and impact of the training, and these should ideally be costed. Mixed methods studies would give a better understanding of the challenges involved with implementing training programs for CHWs and provide evidence for best practice. Training design should consider the background education and prior training received, current roles of the CHWs and how the new skills should complement this role. Training should include demonstration, simulation and on the job supervision to improve confidence of CHWs with their newly learned skills. Communication skills training should focus on changing social norms and behaviours and encouraging the community to work on local fears and myths. CHW attitudes, expression of respect, responsibility and concern should be addressed in training design to assure

development of appropriate relationship between the CHWs and the patients and rest of the community.<sup>[82]</sup> With the available mobile conferencing platforms, follow-up training can be provided to many trainees at a time, remotely as well. Training should be provided onsite where CHWs perform their roles, evidence suggest that onsite training tends to cost less and cause less disruption of the routine functioning of health services, compared to offsite training.<sup>[83]</sup> Better training programs alone will not solve the problems related to opportunities for career growth and professional development via continuing education; the chance to move to the next level within the health system would help motive CHWs to stay in the workforce.<sup>[60]</sup> Attention needs to be paid to CHW remuneration and career development as these are noted challenges affecting the retention of trained CHWs in the workforce. Governments should adopt innovative national planning and provide suitable financial and legal support to ensure the sustainability of implemented programs.<sup>[84-87]</sup> Researchers should consider making the tool kits and resources for CVD management publicly available to other researchers and governments.

Even though our search included all the CHW terminologies used by the WHO and recent reviews on CHWs,<sup>[44]</sup> we may have missed some studies. After expanding the search to include all languages and extending the time limit to the end of 2016, our search identified only 8 studies. The insufficient reporting of study details such as CHWs characteristics, training site, and trainer's profiles led to limited understanding of the contextual factors that influenced the training. Most of the studies were not controlled trials, which made it difficult to investigate the effect of potential confounders. This review included CHWs who were part of the health system and those that volunteered their services. We acknowledge that there is a difference between health volunteers and CHWs,<sup>[88]</sup> but since the overall aim of the paper was to evaluate the effectiveness of training programs for CVD and its risk factors. We feel that remuneration does not impact change in knowledge and skill set. Despite these limitations, our review indicates that training CHWs about CVD and its risk factors is plausible in LMICs.

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3 In conclusion, this review demonstrates that there is not much information about CHW training for  
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5 CVD prevention and control in LMICs. The limited evidence indicates that CHWs can be trained in  
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7 CVD and risk factor prevention and management and can benefit from refresher training. Well  
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9 conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and  
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**Ethics approvals**

An ethics committee approval was not required for this paper as it involved secondary analysis of publicly available data.

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**Conflict of Interest**

None declared

**Author Contributions**

BP drafted the protocol under the supervision of RJ. BP and MA performed the search, extracted the data, and contributed towards the interpretation of the results. MA wrote the first draft. RJ conceived the research question, supervised the review and approved the final version of the manuscript. DP and SA provided critical input towards the manuscript. All the authors reviewed the final draft.

**Data sharing statement**

All the data is available in the systematic review and supplementary files. No extra data is available

**Figure 1. Flow Diagram for systematic review process**

**Figure 2. Change in knowledge scores among CHWs**

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References

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;**3**(11):e442 doi: 10.1371/journal.pmed.0030442[published Online First: Epub Date]].

2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. 1971. Milbank Q 2005;**83**(4):731-57 doi: 10.1111/j.1468-0009.2005.00398.x[published Online First: Epub Date]].

3. Cardiovascular diseases (CVDs). World Health Organization. Fact sheet. Secondary Cardiovascular diseases (CVDs). World Health Organization. Fact sheet 2016. <http://www.who.int/mediacentre/factsheets/fs317/en/>.

4. Celermajer DS, Chow CK, Marijon E, et al. Cardiovascular disease in the developing world: prevalences, patterns, and the potential of early disease detection. Journal of the American College of Cardiology 2012;**60**(14):1207-16 doi: 10.1016/j.jacc.2012.03.074[published Online First: Epub Date]].

5. Maher D, Ford N, Unwin N. Priorities for developing countries in the global response to non-communicable diseases. Global Health 2012;**8**:14 doi: 10.1186/1744-8603-8-14[published Online First: Epub Date]].

6. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. Circulation 1998;**97**(6):596-601

7. Crouse HL, Macias CG, Cruz AT, et al. Utilization of a mobile medical van for delivering pediatric care in the bateys of the Dominican Republic. International Journal of Emergency Medicine 2010;**3** (4):227-32 doi: <http://dx.doi.org/10.1007/s12245-010-0198-4>[published Online First: Epub Date]].

8. Scheffler RM, Liu JX, Kinfu Y, et al. Forecasting the global shortage of physicians: an economic-and needs-based approach. Bulletin of the World Health Organization 2008;**86**(7):516-23B

9. The World Health Report 2006: Working together for health: World Health Organization, 2006.

10. Sharma DC. India still struggles with rural doctor shortages. The Lancet 2015;**386**(10011):2381-82

11. Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. The Lancet 2004;**364**(9449):1984-90

12. Lehmann U, Sanders D. Community health workers: what do we know about them. The state of the evidence on programmes, activities, costs and impact on health outcomes of using community health workers Geneva: World Health Organization 2007:1-42

13. Vaughan K, Kok MC, Witter S, et al. Costs and cost-effectiveness of community health workers: evidence from a literature review. Hum Resour Health 2015;**13**(1):71 doi: 10.1186/s12960-015-0070-y[published Online First: Epub Date]].

14. Neupane D, Kallestrup P, McLachlan CS, et al. Community health workers for non-communicable diseases. Lancet Glob Health 2014;**2**(10):e567 doi: 10.1016/S2214-109X(14)70303-1[published Online First: Epub Date]].

15. Gilmore B, McAuliffe E. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low-and middle-income countries: a systematic review. BMC Public Health 2013;**13**(1):1

16. Tran N, Portela A, de Bernis L, et al. Developing Capacities of Community Health Workers in Sexual and Reproductive. Maternal, Newborn 2014

17. Lawn J, Kerber K. Opportunities for Africa's newborns: practical data policy and programmatic support for newborn care in Africa. 2006

18. Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database Syst Rev 2010(3):CD004015 doi: 10.1002/14651858.CD004015.pub3[published Online First: Epub Date]].

19. Lassi ZS, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. Cochrane Database Syst Rev



- 2015;**3**:CD007754 doi: 10.1002/14651858.CD007754.pub3[published Online First: Epub Date]].
20. Mwai GW, Mburu G, Torpey K, et al. Role and outcomes of community health workers in HIV care in sub-Saharan Africa: a systematic review. *Journal of the International AIDS Society* 2013;**16**(1)
  21. Huicho L, Scherpbier RW, Nkowane AM, et al. How much does quality of child care vary between health workers with differing durations of training? An observational multicountry study. *The Lancet* 2008;**372**(9642):910-16
  22. Hermann K, Van Damme W, Pariyo GW, et al. Community health workers for ART in sub-Saharan Africa: learning from experience—capitalizing on new opportunities. *Human resources for health* 2009;**7**(1):1
  23. Schneider H, Hlophe H, van Rensburg D. Community health workers and the response to HIV/AIDS in South Africa: tensions and prospects. *Health policy and Planning* 2008;**23**(3):179-87
  24. Simon S, Chu K, Frieden M, et al. An integrated approach of community health worker support for HIV/AIDS and TB care in Angonia district, Mozambique. *BMC International Health and Human Rights* 2009;**9**(1):1
  25. Joshi R, Alim M, Kengne AP, et al. Task shifting for non-communicable disease management in low and middle income countries—a systematic review. *PloS one* 2014;**9**(8):e103754
  26. Lehmann U, Van Damme W, Barten F, et al. Task shifting: the answer to the human resources crisis in Africa? *Hum Resour Health* 2009;**7**:49 doi: 10.1186/1478-4491-7-49[published Online First: Epub Date]].
  27. Joshi R, Santo, K., Redfern, K. Task shifting for cardiovascular disease management: What can we learn from other models? *Journal of Cardiology and Therapy* 2014;**1**(5):65-73
  28. Abegunde DO, Shengelia B, Luyten A, et al. Can non-physician health-care workers assess and manage cardiovascular risk in primary care? *Bull World Health Organ* 2007;**85**(6):432-40
  29. Raphael JL, Rueda A, Lion KC, et al. The role of lay health workers in pediatric chronic disease: a systematic review. *Acad Pediatr* 2013;**13**(5):408-20 doi: 10.1016/j.acap.2013.04.015[published Online First: Epub Date]].
  30. Balcazar HG, de Heer HD. Community health workers as partners in the management of non-communicable diseases. *Lancet Glob Health* 2015;**3**(9):e508-9 doi: 10.1016/S2214-109X(15)00142-4[published Online First: Epub Date]].
  31. Mohan V, Deepa M, Pradeepa R, et al. Prevention of diabetes in rural India with a telemedicine intervention. *J Diabetes Sci Technol* 2012;**6**(6):1355-64
  32. Cappuccio FP, Kerry SM, Micah FB, et al. A community programme to reduce salt intake and blood pressure in Ghana [ISRCTN88789643]. *BMC public health* 2006;**6**(1):13
  33. Jafar TH, Islam M, Hatcher J, et al. Community based lifestyle intervention for blood pressure reduction in children and young adults in developing country: cluster randomised controlled trial. *BMJ* 2010;**340**:c2641
  34. Coleman R, Gill G, Wilkinson D. Noncommunicable disease management in resource-poor settings: a primary care model from rural South Africa. *Bull World Health Organ* 1998;**76**(6):633-40
  35. Farzadfar F, Murray CJ, Gakidou E, et al. Effectiveness of diabetes and hypertension management by rural primary health-care workers (Behvarz workers) in Iran: a nationally representative observational study. *Lancet* 2012;**379**(9810):47-54 doi: 10.1016/S0140-6736(11)61349-4[published Online First: Epub Date]].
  36. Alem A, Jacobsson L, Hanlon C. Community-based mental health care in Africa: mental health workers' views. *World Psychiatry* 2008;**7**(1):54-7
  37. Redick C, Dini H. The current state of CHW training programs in Sub-Saharan Africa and South Asia: What we know what we dont know and what we need to do. 2014
  38. Waldman R. Health programming for rebuilding states: a briefing paper. 2007

39. Ryabov I. Cost-effectiveness of Community Health Workers in controlling diabetes epidemic on the U.S.-Mexico border. *Public Health* 2014;**128**(7):636-42 doi: <http://dx.doi.org/10.1016/j.puhe.2014.05.002>[published Online First: Epub Date]] .

40. Pallas SW, Minhas D, Pérez-Escamilla R, et al. Community health workers in low-and middle-income countries: what do we know about scaling up and sustainability? *American journal of public health* 2013;**103**(7):e74-e82

41. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine* 2009;**151**(4):264-69

42. Lariosa T. The role of community health workers in malaria control in the Philippines. *The Southeast Asian journal of tropical medicine and public health* 1991;**23**:30-35

43. Sharma R, Webster P, Bhattacharyya S. Factors affecting the performance of community health workers in India: a multi-stakeholder perspective. *Global health action* 2014;**7**

44. Olaniran A, Smith H, Unkels R, et al. Who is a community health worker?—a systematic review of definitions. *Global health action* 2017;**10**(1):1272223

45. The World Bank. *Country and Lending Groups*, 2016.

46. Thomas H. *Quality assessment tool for quantitative studies*. Effective Public Health Practice Project McMaster University, Toronto 2003

47. Sangprasert P. The effects of a training program for the development of hypertension knowledge and basic skills practice (HKBSP) for Thai community healthcare volunteers. *Siriraj Medical Journal* 2011;**63**(5):163-67

48. Da Silva SSBE, Colosimo FC, Pierin AMG. [The effect of educational interventions on nursing team knowledge about arterial hypertension]. *Revista Da Escola de Enfermagem Da Usp* 2010;**44**(2):488-96

49. Fatmah F. Training Effect on Improving Cadres’ Knowledge and Skills of Obesity and Hypertension in Older People. *Makara Journal of Health Research* 2014:49-54

50. Seyed Emami R, Eftekhar Ardebili H, Golestan B. Effect of a health education intervention on physical activity knowledge, attitude and behavior in health volunteers. *Journal of hayat* 2011;**16**(3):48-55

51. Abrahams-Gessel S, Denman CA, Montano CM, et al. The training and fieldwork experiences of community health workers conducting population-based, noninvasive screening for CVD in LMIC. *Global Heart* 2015;**10** (1):45-54 doi: <http://dx.doi.org/10.1016/j.gheart.2014.12.008>[published Online First: Epub Date]] .

52. Sranacharoenpong K, Hanning RM. Diabetes prevention education program for community health care workers in Thailand. *Journal of Community Health* 2012;**37** (3):610-18

53. Ku GM V , G K. Integrating chronic care with primary care activities: enriching healthcare staff knowledge and skills and improving glycemic control of a cohort of people with diabetes through the First Line Diabetes Care Project in the Philippines. *Global health action* 2014;**7**(25286)

54. Nishtar S, Badar A, Kamal MU, et al. The Heartfile Lodhran CVD prevention project--end of project evaluation. *Promotion & education* 2007;**14** (1):17-27

55. Salter D, Richards L, Carey T. The ‘T5’ Design Model: An Instructional Model and Learning Environment to Support the Integration of Online and Campus - Based Courses. *Educational Media International* 2004;**41**(3):207-18

56. Sranacharoenpong K, Hanning RM. Developing a diabetes prevention education programme for community health-care workers in Thailand: formative findings. *Primary Health Care Research & Development* 2011;**12** (4):357-69 doi: <http://dx.doi.org/10.1017/S146342361100020X>[published Online First: Epub Date]] .

57. Sranacharoenpong K, Hanning RM, Sirichakwal PP, et al. Process and outcome evaluation of a diabetes prevention education program for community healthcare workers in Thailand. *Education for health (Abingdon, England)* 2009;**22** (3):335

58. Gaziano TA, Abrahams-Gessel S, Denman CA, et al. An assessment of community health workers' ability to screen for cardiovascular disease risk with a simple, non-invasive risk assessment instrument in Bangladesh, Guatemala, Mexico, and South Africa: an observational study. *The Lancet Global Health* 2015;**3**(9):e556-e63
59. Abrahams-Gessel S, Denman CA, Montano CM, et al. Lessons from Training and Supervision of Community Health Workers conducting non-invasive, population-based screening for Cardiovascular Disease in Four Communities in Low and Middle-Income Settings: Implications for Scaling Up. *Global heart* 2015;**10**(1):39
60. Bhutta ZA, Lassi ZS, Pariyo G, et al. Global experience of community health workers for delivery of health related millennium development goals: a systematic review, country case studies, and recommendations for integration into national health systems. *Global Health Workforce Alliance* 2010;**1**:249-61
61. Armstrong G, Kermode M, Raja S, et al. A mental health training program for community health workers in India: impact on knowledge and attitudes. *International journal of mental health systems* 2011;**5**(1):17
62. Ogedegbe G, Gyamfi J, Plange-Rhule J, et al. Task shifting interventions for cardiovascular risk reduction in low-income and middle-income countries: a systematic review of randomised controlled trials. *BMJ open* 2014;**4**(10) doi: 10.1136/bmjopen-2014-005983[published Online First: Epub Date] ].
63. Rowe AK, de Savigny D, Lanata CF, et al. How can we achieve and maintain high-quality performance of health workers in low-resource settings? *The Lancet*; **366**(9490):1026-35 doi: 10.1016/S0140-6736(05)67028-6[published Online First: Epub Date] ].
64. Kamath DY, Xavier D, Gupta R, et al. Rationale and design of a randomized controlled trial evaluating community health worker-based interventions for the secondary prevention of acute coronary syndromes in India (SPREAD). *American Heart Journal* 2014;**168** (5):690-97 doi: <http://dx.doi.org/10.1016/j.ahj.2014.07.029>[published Online First: Epub Date] ].
65. van de Vijver S, Oti S, Addo J, et al. Review of community-based interventions for prevention of cardiovascular diseases in low- and middle-income countries. *Ethnicity & Health* 2012;**17**(6):651-76 doi: <http://dx.doi.org/10.1080/13557858.2012.754409>[published Online First: Epub Date] ].
66. Surka S, Edirippulige S, Steyn K, et al. Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers. *International Journal of Medical Informatics* 2014;**83**(9):648-54 doi: <http://dx.doi.org/10.1016/j.ijmedinf.2014.06.008>[published Online First: Epub Date] ].
67. Botes AS, Majikela-Dlangamandla B, Mash R. The ability of health promoters to deliver group diabetes education in South African primary care. *African Journal of Primary Health Care and Family Medicine* 2013;**5**(1)
68. Khan M, Kamal AK, Islam M, et al. Can Trained Field Community Workers Identify Stroke Using a Stroke Symptom Questionnaire as well as Neurologists?: Adaptation and Validation of a Community Worker Administered Stroke Symptom Questionnaire in a Peri-urban Pakistani Community. *Journal of Stroke and Cerebrovascular Diseases* 2015;**24**(1):91-99
69. Balagopal P, Kamalamma N, Patel TG, et al. A community-based participatory diabetes prevention and management intervention in rural India using community health workers. *Diabetes Educ* 2012;**38**(6):822-34 doi: <http://dx.doi.org/10.1177/0145721712459890>[published Online First: Epub Date] ].
70. Xavier D, Gupta R, Kamath D, et al. Community health worker-based intervention for adherence to drugs and lifestyle change after acute coronary syndrome: a multicentre, open, randomised controlled trial. *The Lancet Diabetes & Endocrinology*; **4**(3):244-53 doi: 10.1016/S2213-8587(15)00480-5[published Online First: Epub Date] ].

71. Joshi R, Chow CK, Raju PK, et al. The Rural Andhra Pradesh Cardiovascular Prevention Study (RAPCAPS): a cluster randomized trial. *Journal of the American College of Cardiology* 2012;**59**(13):1188-96

72. Dongbo F, Hua F, McGowan P, et al. Implementation and quantitative evaluation of chronic disease self-management programme in Shanghai, China: randomized controlled trial. *Bulletin of the World Health Organization* 2003;**81**(3):174-74 1p

73. West-Pollak A, Then EP, Podesta C, et al. Impact of a novel community-based lifestyle intervention program on type 2 diabetes and cardiovascular risk in a resource-poor setting in the Dominican Republic. *International Health* 2014;**6**(2):118-24 doi: <http://dx.doi.org/10.1093/inthealth/ih039>[published Online First: Epub Date] | .

74. Micikas M, Foster J, Weis A, et al. A community health worker intervention for diabetes self-management among the Tz'utujil Maya of Guatemala. *Health Promotion Practice* 2015;**16**(4):601-08

75. Saranrittichai K, Senarak W, Promthet S, et al. Health behavior after a multiprofessional intervention and training for ongoing volunteer-based community health programme intervention in the North-East of Thailand: what changed and what not? *Asian Pacific Journal of Cancer Prevention* 2012;**13**(9):4801-05

76. Denman CA, Rosales C, Cornejo E, et al. Evaluation of the community-based chronic disease prevention program Meta Salud in Northern Mexico, 2011-2012. *Preventing Chronic Disease* 2014;**11**:E154 doi: <http://dx.doi.org/10.5888/pcd11.140218>[published Online First: Epub Date] | .

77. Cornejo E, Denman CA, Sabo S, et al. Scoping review of community health worker/promotora-based chronic disease primary prevention programs on the US-Mexico border. *alamo colson edu mx* 2011;**8085**

78. Alvarez K, Salas E, Garofano CM. An integrated model of training evaluation and effectiveness. *Human resource development Review* 2004;**3**(4):385-416

79. Wang GG, Wilcox D. Training evaluation: knowing more than is practiced. *Advances in Developing Human Resources* 2006;**8**(4):528-39

80. Kaufman R, Keller JM. Levels of evaluation: beyond Kirkpatrick. *Human Resource Development Quarterly* 1994;**5**(4):371-80

81. Bates R. A critical analysis of evaluation practice: the Kirkpatrick model and the principle of beneficence. *Evaluation and program planning* 2004;**27**(3):341-47

82. Perry H, Crigler L. Developing and strengthening community health worker programs at scale. A reference guide and case studies for program managers and policymakers. 2013

83. Ritchie LMP, Schull MJ, Martiniuk AL, et al. A knowledge translation intervention to improve tuberculosis care and outcomes in Malawi: a pragmatic cluster randomized controlled trial. *Implementation Science* 2015;**10**(1):1

84. Kok MC, Dieleman M, Taegtmeier M, et al. Which intervention design factors influence performance of community health workers in low-and middle-income countries? A systematic review. *Health policy and planning* 2015;**30**(9):1207-27

85. Abbey M, Bartholomew LK, Nonvignon J, et al. Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana. *International health* 2014;**6**(2):99-105

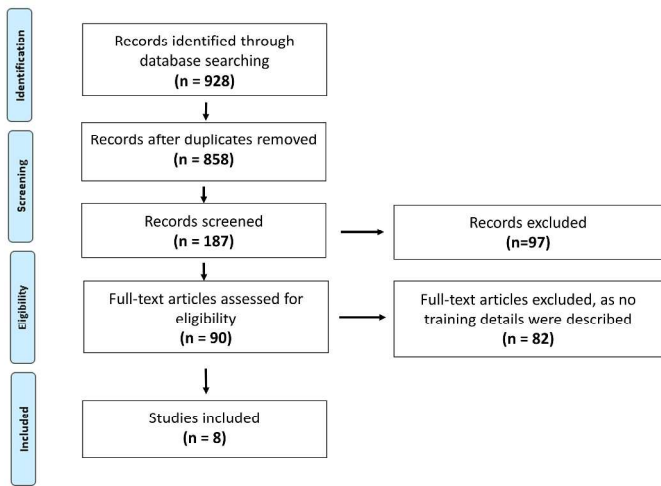
86. Bhattacharyya K, Winch P, LeBan K, et al. Community Health Worker Incentives and Disincentives: How They Affect Motivation, Retention, and Sustainability. Published by the Basic Support for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for International Development. Arlington, Virginia.

87. Research on community-based health workers is needed to achieve the sustainable development goals. *Bulletin of the World Health Organization*. November 2016 ed, 2016:786-86.

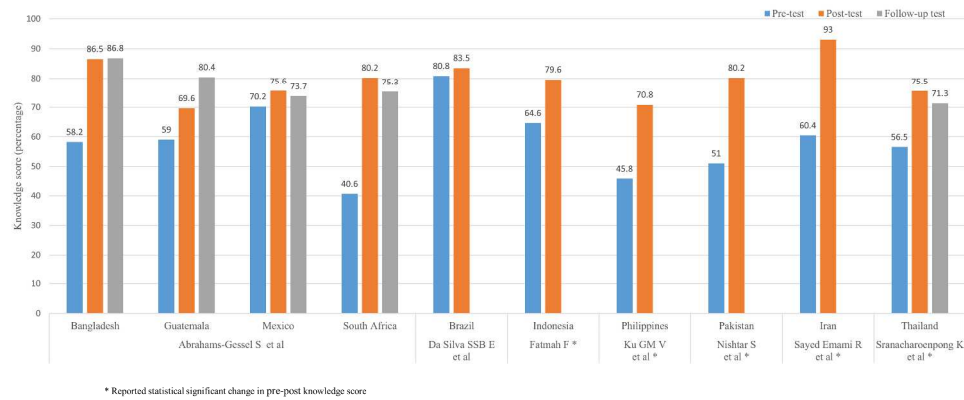
- 1  
2  
3 88. Vareilles G, Pommier J, Marchal B, et al. Understanding the performance of community health  
4 volunteers involved in the delivery of health programmes in underserved areas: a realist  
5 synthesis. Implementation Science 2017;**12**(1):22  
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APPENDIX 1

Free text terms used in the databases on the OVID platform (Medline, Global Health, ERIC, Embase):

CHW Group (Population)

1. (Communit\* health\* adj3 (work\* or staff or employee\* or provider\* or distributor\* or surveyor\* or assistant\* or promoter\* or facilitator\* or agent\*)).tw.
2. (Non-physician health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
3. CHW.tw.
4. LHW.tw.
5. (Lay health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
6. Volunteer health\* work\*.tw.
7. Voluntary health\* work\*.tw.
8. Promotoras de salud.tw.
9. (rural health adj3 (auxiliar\* or motivator\*)).tw.
10. Traditional midwi\*.tw.
11. TBA.tw.
12. Traditional birth attendant\*.tw.
13. Health\* promoter\*.tw.
14. Basic health\* work\*.tw.
15. Communit\* nutrition work\*.tw.
16. Communit\* resource person.tw.
17. (Female adj3 (multipurpose health\* work\* or volunteer\*)).tw.
18. (Maternal and child health\* work\*).tw.
19. Mother coordinator\*.tw.
20. Outreach educator\*.tw.
21. Paramedic\* work\*.tw.
22. (Village health\* adj3 (work\* or helper\* or guide\*)).tw.
23. Shasthyo Sebikas.tw
24. ASHA.tw
25. Female community health volunteer\*.tw
26. Community-based health worker\*.tw.
27. Beharv\*.tw.
28. Community Care Worker\*.tw.
29. Care Facilitator\*.tw.
30. Community-based reproductive health agents\*.tw.
31. Animatrice de Sante Maternelle\*.tw.
32. Binome de Sante Maternelle\*.tw.

33. Community Health Development Agent\*.tw.
34. Agentes Polivalentes Elementares\*.tw.
35. Community-based Educators\*.tw.
36. Health Extension Worker\*.tw.
37. Health Surveillance Assistant\*.tw.
38. Lay volunteer\*.tw.
39. Shasthyo kormis\*.tw.
40. Community health care practitioners\*.tw.
41. Health assistants\*.tw.
42. Family welfare assistants\*.tw.

LMIC Group (Population)

1. LMIC.mp
2. ((Low or middle) adj income countr\*).mp
3. Developing countr\*.mp
4. South East Asia\*.tw
5. Southeast\* Asia\*.mp.
6. Sub-Saharan Africa\*.tw.
7. Sub-Saharan Africa\*.mp.
8. Afghan\*.mp.
9. Benin\*.mp.
10. Burkina\*.mp.
11. Burundi\*.mp.
12. Cambodia\*.mp.
13. Central African Republic\*.mp.
14. Chad\*.mp.
15. Comor\*.mp.
16. Congo\*.mp.
17. Eritrea\*.mp.
18. Ethiopia\*.mp.
19. Gambia\*.mp.
20. Guinea\*.mp.
21. Haiti\*.mp.
22. North Korea\*.mp.
23. Liberia\*.mp.
24. Madagas\*.mp.
25. Malawi\*.mp.
26. Mali\*.mp.
27. Mozambi\*.mp.
28. Nepal\*.mp.
29. Niger\*.mp.
30. Rwanda\*.mp.
31. Sierra Leone\*.mp.
32. Somalia\*.mp.
33. South Sudan\*.mp.
34. Tanzania\*.mp.
35. Togo\*.mp.



36. Uganda\*.mp.
37. Zimbabwe\*.mp.
38. Armenia\*.mp.
39. Bangladesh\*.mp.
40. Bhutan\*.mp.
41. Bolivia\*.mp.
42. Cape Verd\*.mp.
43. Cameroon\*.mp.
44. Cote d'Ivoire.mp.
45. Ivorian.mp.
46. Djibouti\*.mp.
47. Egypt\*.mp.
48. Salvador\*.mp.
49. Georgia\*.mp.
50. Ghana\*.mp.
51. Guatemala\*.mp.
52. Guyan\*.mp.
53. Hondura\*.mp.
54. India\*.mp.
55. Indonesia\*.mp.
56. Kenya\*.mp.
57. Kiribati\*.mp.
58. Kosov\*.mp.
59. Kyrgyz\*.mp.
60. Lao\*.mp.
61. Lesotho\*.mp.
62. Mauritania\*.mp.
63. Micronesia\*.mp.
64. Moldova\*.mp.
65. Morocc\*.mp.
66. Myanmar\*.mp.
67. Burm\*.mp.
68. Nigeria\*.mp.
69. Pakistan\*.mp.
70. Nicaragua\*.mp.
71. Papua New Guinea\*.mp.
72. Philippin\*.mp.
73. Filipino.mp.
74. Samoa\*.mp.
75. Sao Tome\*.mp.
76. Senegal\*.mp.
77. Solomon\*.mp.
78. Sri Lanka\*.mp.
79. Sudan\*.mp.
80. Swazi\*.mp.
81. Syria\*.mp.
82. Tajik\*.mp.
83. Timor\*.mp.
84. Ukrain\*.mp.
85. Uzbek\*.mp.
86. Vanuatu\*.mp.
87. Vietnam\*.mp.
88. West bank.mp.
89. Gaza\*.mp.
90. Yemen\*.mp.
91. Zambia\*.mp.
92. Albania\*.mp.
93. Algeria\*.mp.
94. Angola\*.mp.
95. Azerbaijan\*.mp.
96. Belarus\*.mp.
97. Belize\*.mp.
98. Bosnia\*.mp.
99. Herzegovin\*.mp.
100. Botswana.mp.
101. Batswana.mp.
102. Brazil\*.mp.
103. Bulgaria\*.mp.
104. Chin\*.mp.
105. Colombia\*.mp.
106. Costa Rica\*.mp.
107. Cuba\*.mp.
108. Dominica\*.mp.
109. Ecuador\*.mp.
110. Fiji\*.mp.
111. Gabon\*.mp.
112. Grenad\*.mp.
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114. Iraq\*.mp.
115. Jamaica\*.mp.
116. Jordan\*.mp.
117. Kazakh\*.mp.
118. Leban\*.mp.
119. Libya\*.mp.
120. Macedonia\*.mp.
121. Malaysia\*.mp.
122. Maldiv\*.mp.
123. Marshall Island\*.mp.
124. Mauriti\*.mp.
125. Mexic\*.mp.
126. Mongolia\*.mp.
127. Montenegr\*.mp.
128. Namibia\*.mp.
129. Palau\*.mp.
130. Panama\*.mp.
131. Paraguay\*.mp.
132. Peru\*.mp.
133. Romania\*.mp.
134. Serbia\*.mp.
135. South Africa\*.mp.
136. St Lucia\*.mp.
137. (St Vincent and the Grenadines).mp.

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138. Vincentian.mp.

139. Suriname\*.mp.

140. Thai\*.mp.

141. Tonga\*.mp.

142. Tunisia\*.mp.

143. Turk\*.mp.

144. Tuvalu\*.mp.

**NCD/CVD Group (Intervention)**

1. Diabet\*.tw.

2. Obes\*.tw.

3. Overweight.tw.

4. Cardiovascular Disease\*.tw.

5. Hypertens\*.tw.

6. Non-communicable Disease\*.tw.

7. Chronic Disease\*.tw.

8. NCD.tw.

9. CVD.tw.

10. Coronary Heart Disease\*.tw.

11. Cerebrovascular disease\*.tw.

12. Peripheral arter\* disease\*.tw.

13. Rheumatic Heart disease\*.tw.

14. Congenital heart disease\*.tw.

15. Deep vein thrombosis.tw.

16. Deep venous thrombosis.tw.

17. Pulmonary embol\*.tw.

18. Unhealthy diet.tw.

19. Physical inactivity.tw.

20. Sedentary lifestyle\*.tw.

21. Tobacco.tw.

22. Alcohol.tw.

23. Hypercholesterol?emia.tw.

24. Hyperlipid?emia.tw.

**Training Programs Group (Intervention)**

1. ((education\* or train\*) adj2 program\*).tw.

Medical Subject Headings (MeSH) terms used for each database:

Medline

**CHW Group (Population)**

26. Community health workers/

27. Home health aides/

28. Community health services/

**LMIC Group (Population)**

145. Developing Countries/

146. Asia, Southeastern/

147. exp "Africa South of the Sahara"/

148. "Democratic People's Republic of Korea"/

149. exp Micronesia/

**NCD/CVD Group (Intervention)**

25. Chronic Disease/

26. Diabetes Mellitus/

27. exp Diabetes Mellitus, Type 2/

28. exp Obesity/

29. Overweight/

30. Cardiovascular Diseases/

31. exp Heart Diseases/

32. exp Vascular Diseases/

33. Diet, High-Fat/

34. Diet, Western/

35. Diet/

36. exp "Tobacco Use"/

37. exp "Tobacco Use Cessation"/

38. exp lipoproteins, ldl/

39. exp lipoproteins, vldl/

40. Cholesterol, Dietary/

41. Hypercholesterolemia/

42. Hyperlipidemias/

43. exp Obesity/

44. Overweight/

45. Prediabetic state/

46. Sedentary Lifestyle/

47. exp Drinking Behavior/

48. exp Cerebrovascular Disorders/

49. Rheumatic Heart Disease/

50. exp Heart Defects, Congenital/

**Training Programs Group (Intervention)**

2. "early intervention (education)"/

3. health education/

4. Education/

5. Education, Nonprofessional/

6. Program Evaluation/

Global Health

**CHW Group (Population)**

26. community health services/

27. medical auxiliaries/

28. health care workers/

29. traditional health services/"C

30. traditional birth attendants/

**LMIC Group (Population)**

145. developing countries/

146. south east asia/
147. exp indochina/
148. taiwan/
149. "africa south of sahara"/
150. korea democratic people's republic/
151. sudan/
152. exp micronesia/
153. exp "federated states of micronesia"/
154. least developed countries/

#### **NCD/CVD Group (Intervention)**

25. chronic diseases/
26. exp diabetes/
27. type 2 diabetes/
28. obesity/
29. obesity hyperglycaemia syndrome/
30. overweight/
31. exp cardiovascular diseases/
32. exp hypertension/
33. thrombosis/
34. exp heart diseases/
35. exp vascular diseases/
36. diet/
37. physical activity/
38. exp tobacco/
39. tobacco smoking/
40. exp smoking cessation/
41. alcohol intake/
42. hyperlipaemia/
43. hypercholesterolaemia/
44. cholesterol/

#### **Training Programs Group (Intervention)**

2. education/
3. program development/
4. Program effectiveness/
5. Program evaluation/
6. education programmes/
7. health education/
8. medical education/
9. professional education/
10. training/
11. training courses/
12. training officers/

#### **ERIC**

#### **CHW Group (Population)**

26. community health services/
27. home health aides/
28. home programs/

29. exp Paraprofessional Personnel/
30. Lay people/

#### **LMIC Group (Population)**

145. developing nations/

#### **NCD/CVD Group (Intervention)**

25. chronic illness/
26. diabetes/
27. exp body weight/
28. hypertension/
29. exp Physical Activity Level/
30. physical fitness/
31. exp smoking/
32. exp alcohol abuse/
33. eating habits/

#### **Training Programs Group (Intervention)**

2. caregiver training/
3. volunteer training/
4. health education/
5. nonformal education/
6. exp job training/
7. professional training/
8. "Institutes (Training Programs)"/
9. Professional development/
10. Professional education/
11. teaching methods/
12. health promotion/
13. exp formative evaluation/
14. program development/
15. program improvement/
16. summative evaluation/
17. Program Evaluation/
18. program effectiveness/
19. Duplication/
20. Programs/
21. Program validation/
22. Outcome measures/
23. "Outcomes of education"/
24. Pretests posttests/
25. Educational assessment/
26. Educational quality/
27. "replication (evaluation)"/
28. program guides/
29. program implementation/
30. program design/
31. Programmed Instructional Materials/
32. exp Instructional Materials/
33. material development/
34. Instructional Material evaluation/

- 35. exp training methods/
- 36. training/
- 37. trainers/

Embase

CHW Group (Population)

- 26. exp Health Auxiliary/
- 27. Health educator/
- 28. Diabetes educator/
- 29. exp Health care manpower/
- 30. Health care personnel
- 31. exp Traditional birth attendant/

LMIC Group (Population)

- 145. exp Lowest income group/
- 146. exp Developing country/
- 147. exp Africa South of the Sahara/
- 148. exp Southeast Asia

NCD/CVD Group (Intervention)

- 25. exp Cardiovascular disease/
- 26. exp Non communicable disease/
- 27. exp Chronic disease/
- 28. exp Diabetes Mellitus/
- 29. exp Hypertension/
- 30. exp Obesity/
- 31. exp hyperglycemia/
- 32. Weight gain/
- 33. Diet/
- 34. Western Diet/
- 35. exp Hyperlipidemia/
- 36. Alcohol consumption/
- 37. "tobacco use"/
- 38. tobacco dependence/
- 39. physical inactivity

Training Programs Group (Intervention)

- 2. exp Health program/
- 3. exp Education/
- 4. exp Accreditation/
- 5. exp Health education/
- 6. exp Medical education/
- 7. exp Teaching/
- 8. exp Staff training/
- 9. exp Training/
- 10. exp Program evaluation/

CINAHL

CHW Group (Population)

- 26. Community Health Worker
- 27. Lay Midwives
- 28. Community Health Services

LMIC Group (Population)

- 145. Developing Countries
- 146. Africa South of the Sahara
- 147. Asia, Southeastern

NCD/CVD Group (Intervention)

- 25. Alcohol Drinking+
- 26. Cardiovascular Diseases+
- 27. Cardiovascular Risk Factors
- 28. Cerebrovascular Disorders+
- 29. Chronic Disease
- 30. Diabetes Mellitus
- 31. Diabetes Mellitus, Type 2
- 32. Diet
- 33. Diet, Western
- 34. Hyperlipidemia+
- 35. Life Style, Sedentary
- 36. Lipoproteins, LDL+
- 37. Obesity+
- 38. Prediabetic State+
- 39. Smoking Cessation Programs
- 40. Tobacco Products+

Training Programs Group (Intervention)

- 2. Education+
- 3. Program Development+
- 4. Quality Assessment+
- 5. Professional Development



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4,5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Yes
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5,6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6,7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ for each meta-analysis)	6,7,8



PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8-14
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14,15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11, Figure 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Due to heterogeneity of data, a meta-analysis was not done.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14,15
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Not applicable
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16,17,18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18,19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19,20
FUNDING			



## PRISMA 2009 Checklist

Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21
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From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: [www.prisma-statement.org](http://www.prisma-statement.org).

Page 2 of 2

For peer review only

# BMJ Open

## The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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Manuscript ID	bmjopen-2016-015529.R3
Article Type:	Research
Date Submitted by the Author:	13-Sep-2017
Complete List of Authors:	Abdel-All, Marwa; The George Institute for Global Health; University of Sydney Putica, Barbara; University of Sydney Praveen, D; The George Institute for Global Health Abimbola, Seye; The George Institute for Global Health; University of Sydney Joshi, Rohina; The George Institute for Global Health; University of Sydney
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Global health, Health policy, Medical education and training, Public health, Patient-centred medicine
Keywords:	Cardiovascular disease, Community Health Worker, Training, Low and Middle Income Countries

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Manuscripts

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The effectiveness of community health worker training programs for cardiovascular disease management in low and middle income countries – a systematic review

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Word count 4106

## Abstract

### Introduction

Community health workers (CHWs) are increasingly being tasked to prevent and manage cardiovascular disease and its risk factors in underserved populations in low and middle income countries (LMIC); however, little is known about the required training necessary for them to accomplish their role. This review aimed to evaluate the training of CHWs for the prevention and management of cardiovascular disease and its risk factors in LMIC.

### Methods

A search strategy was developed in line with PRISMA guidelines and 5 electronic databases (Medline, Global Health, ERIC, EMBASE and CINAHL) were searched to identify peer reviewed studies published till December 2016 on the training of CHWs for prevention or control of cardiovascular disease and its risk factors in LMIC. Study characteristics were extracted using a Microsoft excel spread sheet and quality assessed using Effective Public Health Practice Project's Quality Assessment Tool. The search, data extraction and quality assessment were performed independently by two researchers.

### Results

The search generated 928 articles of which eight were included in the review. One study was a randomised controlled trial, while the remaining were before-after intervention studies. The training methods included classroom lectures, interactive lessons, e-learning and online support, and group discussions or a mix of two or more. All the studies showed improved knowledge level post-training and two studies demonstrated knowledge retention six months after the intervention.

### Conclusion

The results of the eight included studies suggest CHWs can be trained effectively for CVD prevention and management. However, the effectiveness of CHW trainings would likely vary depending on context given the differences between studies (e.g., CHW demographics, settings, and training programs), and the weak quality of six of the eight studies. Well conducted mixed methods studies are needed to provide reliable evidence about the effectiveness and cost-effectiveness of training programs for CHWs.

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**Strengths and limitations of this study**

- First systematic review to evaluate the effectiveness of training community health workers for the prevention and management of cardiovascular disease and its risk factors in Low and Middle Income Countries.
- The review was conducted in accordance to the PRISMA guidelines.
- Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)’s Quality Assessment Tool.
- Limited number of studies with insufficient data regarding training methods, outcomes and characteristics of CHWs.
- Most of the studies were not controlled, which made it difficult to investigate the effect of potential confounders on the performance of the CHWs.

## INTRODUCTION

### Cardiovascular Diseases in developing countries

Globally, the burden of non-communicable diseases (NCDs) is rising with the cause specific mortality fraction due to NCDs estimated to be 69% in 2030 compared to 59% in 2002.<sup>[1]</sup> This shift is largely driven by a demographic and epidemiologic transition, coupled with rapid urbanization and nutritional transitions in developing countries.<sup>[2]</sup> Currently, cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the developed and developing countries alike, with a greater burden being felt by the latter, as they carry a higher proportion of premature deaths from cardiovascular events.<sup>[3-4]</sup> Most health systems in low- and middle-income countries (LMICs) are unprepared to manage the increasing burden of CVDs as their health systems are often focused on infectious diseases and maternal and child health, rather than chronic diseases.<sup>[5-6]</sup>

### The health workforce for CVD

Access to primary care for CVD prevention and treatment in LMIC can often be challenging<sup>[7]</sup> as these countries have the highest global disease burden and tend to experience some of the greatest shortages in physicians and health workers.<sup>[8]</sup> For example, there are 2.3 health workers per 1000 population in Africa, and 4.3 per 1000 population in South-East Asia.<sup>[9]</sup> A maldistribution of these health workers often exist with a higher concentration of health workers in urban areas compared to rural regions where large proportions of the population resides.<sup>[9-11]</sup> This poor distribution and shortage of health professionals has led some countries to rely on trained community health workers (CHWs), who take on specific tasks for the prevention and management of diseases.

### Community health workers

The World Health Organisation (WHO) defines CHWs as individuals who perform functions related to health-care delivery; have shorter training than professional health workers, are community members, selected by and answerable to the community for their activities and are usually supported by the health system but not necessarily a part of its organization. Typically, they are trained for

specific tasks such as provision of antenatal care or immunisation and often do not hold any formal certifications.<sup>[12]</sup> CHWs have been effective in providing essential health care services in a cost-effective manner.<sup>[13-14]</sup> They have been instrumental in reducing maternal and neonatal mortality rates through their presence in at-home births and making referrals for emergency obstetric care,<sup>[15-17]</sup> and by promoting vaccination uptake, breastfeeding, and education on infectious disease.<sup>[18-19]</sup> More recently, CHWs have been useful in HIV/AIDS prevention and control, educating communities and performing tasks such as testing, counselling and prescribing antiretroviral drugs.<sup>[20-24]</sup> This transfer of responsibilities onto CHWs is commonly referred to as task shifting, which is common in regions with limited access to physicians.<sup>[25-27]</sup> This increase in responsibility has been noted throughout the global health community, and it is not uncommon for CHWs to hold different titles based on the country where they work or the tasks for which they are responsible (such as non-physician healthcare worker, lay health worker, traditional birth attendant, accredited social health activist, Barangay Health worker, etc.).<sup>[12]</sup>

Over the last 10 years, CHWs have had an increasing role in CVD prevention and control.<sup>[28-32]</sup> Although research into the effect of CHWs in CVD prevention and control is relatively new, there is emerging evidence which yields promising results.<sup>[33-36]</sup> There is considerable amount of data and manuals available to help train CHWs for management of infectious diseases and maternal and child health in LMIC,<sup>[37-39]</sup> however, there is a lack of evidence based information regarding the content and method to train CHWs for CVD prevention and control.<sup>[40]</sup> Effective training and re-training are essential for the knowledge and skill-set required for good quality performance. This systematic review aims to provide comprehensive insight into CHW training programs for CVD prevention and control, and provides an evidence base for the effectiveness of training programs in the LMIC context.

**METHODS**

A protocol was written to define the inclusion and exclusion criteria and the methods for the review prior to data extraction in accordance to the PRISMA guidelines.<sup>[41]</sup> Five data bases including Medline

via OvidSP, Global Health via OvidSP, ERIC via OvidSP, Embase via OvidSP, and CINAHL via EBSCO were reviewed.

### **Inclusion and exclusion criteria**

The population considered for this systematic review was CHWs in LMICs. Synonyms for CHWs included in the search were taken from the WHO report on CHWs,<sup>[12]</sup> and other terms based on literature reviews.<sup>[42-44]</sup> A medical librarian was consulted to ensure integrity of our search. The review included intervention studies which offered training programs for CHWs in CVD and cardiovascular risk factor prevention (screening, health promotion) or control (monitoring, management). Papers included were specific in what type of training methods were used, i.e. which topics were covered, length and outcomes of the training programs, etc. Studies were limited to CVDs and their modifiable risk factors including high blood pressure, diabetes, dyslipidaemia, alcohol consumption, tobacco use and physical inactivity. A complete list of free text search terms and subject headings are supplied in Appendix 1. The comparator variable for this paper included pre-service training and the outcome of interest was an improvement in skills and knowledge of CHWs in the prevention and control of CVDs and their risk factors after the training program. Types of studies included were pre-post observational studies, and randomised controlled trials published till 31 December, 2016. Papers in all languages were searched and those in a language other than English were translated. If a study was reported in more than one paper, information from all the papers was included in the review, but the study was counted once.

Studies were limited to those which were explicit in specifying what type of training was done and reported pre-post test scores for CHWs. They included countries classified during 2015 as low-, lower-middle, and upper-middle income countries in the World Bank's Income Classifications.<sup>[45]</sup>

### **Data collection**

After agreeing on the search strategy to be used, two authors (BP, MA) reviewed the literature and extracted the data independently. The number of studies included at each stage of literature search was agreed upon between the two authors to ensure no papers were missed and discrepancies were dealt by consensus. (Figure 1) Data was collected on a pre-specified excel sheet after approval of all reviewers, with variables clearly outlined. The first paper to be included was extracted independently then the data was compared between authors to confirm what was to be expected to report for each variable. This sheet was modified to include all information that was important as data extraction continued. Weekly meetings were held between the data extractors to discuss any disagreements about the inclusion of a paper. If any disagreements, a third author (RJ) was asked to adjudicate. At the end of data extraction, all reviewers met to note any discrepancies and agree on the final data extraction. The references of all the included papers were checked for additional relevant papers. When necessary, corresponding authors of included papers were contacted regarding missing information in the published papers. Quality of studies was assessed and papers were critically appraised using Effective Public Health Practice Project (EPHPP)'s Quality Assessment Tool.<sup>[46]</sup> The Tool provides an overall methodological rating of the studies of strong, moderate or weak as per six components including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts. Studies were rated strong if the study population was representative of the target population; had a robust study design such as a randomised controlled trial; controlled for confounding, used validated data collection tools, and had a low drop-out rate of the study participants. Two authors (BP, MA) followed the quality assessment tool and rated the studies independently and discussed discrepancies by consensus. No study was excluded based on the quality assessment.

**Data analysis**

To demonstrate the change in knowledge and skills among CHWs, pre- and post-test scores and post intervention scores, published in the eight papers were used to evaluate the effectiveness of training. No additional statistical analysis was done as individual test scores were not available and scores were not standardised across the eight studies. All studies were reviewed and a narrative synthesis was conducted to assess the studies comprehensively. The data were tabulated to explore the relationship

between and within the included studies. Themes from the qualitative data reported were used to assess the CHWs perception and experience of the training. A meta-analysis was not performed due to heterogeneity of the studies.

## RESULTS

### Characteristics of included studies, CHWs and trainers

The initial search yielded 928 citations published between the period of 1959 and 2016. After removing duplicates 858 titles and 187 abstracts were screened. Ninety studies were assessed for a full-review, of which eight studies were included. Figure 1 outlines the systematic review process. The selected studies were conducted between the year 2000 and 2013, and published between the year 2007 and 2015. Four of the studies were conducted in rural or semi-urban areas and four studies did not mention details about the study site.<sup>[47-50]</sup> None of the studies discussed the cost of training involved or the cost-effectiveness of the training.

The studies included Community Health Workers from Bangladesh, Guatemala, Mexico, South Africa<sup>[51]</sup> and Thailand,<sup>[52]</sup> Community Health Agents from Brazil,<sup>[48]</sup> Cadres Posbindu and Community Health Centre staff from Indonesia,<sup>[49]</sup> Barangay Health Workers from the Philippines,<sup>[53]</sup> Lady Health Workers from Pakistan<sup>[54]</sup> and Healthcare Volunteers from Iran<sup>[50]</sup> and Thailand.<sup>[47]</sup> The number of trained health workers varied from 35<sup>[52]</sup> to 299<sup>[54]</sup> and were mostly women (75-100%). The education of CHWs varied from primary school<sup>[47 53]</sup> to Master Degree holders.<sup>[51 52]</sup> In most studies, the health workers were part of the health system receiving a salary, except in Guatemala where a monthly incentive was provided<sup>[51]</sup> and Iran and Thailand, where CHWs were volunteers from the community.<sup>[47 50]</sup> The training team included health professionals,<sup>[51]</sup> project officers<sup>[54]</sup> and researchers.<sup>[48]</sup> Four studies did not provide details about the trainers.<sup>[47 49 50 52]</sup> Detailed characteristics of the CHWs and trainers are provided in Table 1.



**Table1: Characteristics of Community Health Workers and Trainers**

Study	Type of Health workers (Country of study)	Number of CHWs	Sex	Age	Education	Relation to health system	Trainers
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Community Health Worker (Bangladesh, Guatemala, Mexico & South Africa)	64	84% Females	Not reported	B: Secondary to Master's Degree, G: Secondary, M: Secondary, SA: Secondary	B: NGO employed G: NGO employed M: Government employed SA: NGO employed	Health professionals: physicians, nurses, and nutritionists
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Community Health Agents (Brazil)	37	90.9% Females	50% of CHWs were up to 40 years	Secondary (67.3%)	Government employed	Researchers
Fatmah F, 2014 <sup>[49]</sup>	Cadres Posbindu and Community Health centre staff (Indonesia)	45	100% Females	Mean age 43.3	Primary (26.7%) Secondary (46.7%) Diploma (26.7%)	Government employed	Not reported
Ku GM V et al, 2014 <sup>[53]</sup>	Barangay Health Worker (Philippines)	87	Not reported	Not reported	Primary (8%), Secondary (42%), University (50%)	Government employed	Principal investigators and trained nurses
Nishtar S et al, 2007 <sup>[54]</sup>	Lady Health Worker (Pakistan)	299	100% Females	Not reported	Not reported	Government employed	Heartfile Officer (project officer)
Sangprasert P, 2011 <sup>[47]</sup>	Healthcare Volunteer (Thailand)	75	75% Females	Mean age 49.5	Primary (56.4%), Secondary (30.1%), Diploma (9.7%), University (3.8%)	Volunteers	Not reported
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health Volunteer (Iran)	80	100% Females	Not reported	Primary (39.0%) Secondary (48.1%) University (12.2%)	Volunteers	Not reported
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Community Health Care Worker (Thailand)	35	97% Females	25-34y – (17%), 35-44y – (63%), 45-54y – (20%)	Diploma (5.7%), University (88.6%), Master's (5.7%)	Government employed	Not reported

Note: B (Bangladesh) / G (Guatemala) / M (Mexico) / SA (South Africa)  
NGO (Non-governmental organization)

### Details regarding training methods

Studies used different approaches to develop the curriculum and disseminate knowledge. Training methods included interactive modes like problem-based learning, classroom discussions, demonstrations, media presentations, role-plays, as well as self-training quizzes and assignments, which were either online<sup>[52]</sup> or paper based.<sup>[51]</sup> Training designs included the T5 instructional learning design (Tasks, tutorials, tools, topics, and teamwork) allowing interactive learning,<sup>[55]</sup> or adapting existing education and training materials available from high income countries.<sup>[51]</sup> In one of the studies, CHWs were trained alongside nurses on hypertension, its treatment and its burden through interactive classes.<sup>[48]</sup> The training varied, from 2.5 hours<sup>[50]</sup> up to 40 hours<sup>[52]</sup> over a four to six month period. (Table 2) Training took place at the local health units in four studies<sup>[48 50 52 54]</sup> while the other three studies did not mention details about the training site. Training focused on CVD and its risk factors, healthy lifestyle and dietary habits and physical activity. Four of the studies<sup>[47 51-53]</sup> trained CHWs on anthropometric measurement skills and their interpretation and one study trained CHWs to use a BMI (Body Mass Index) metric tool for nutritional status assessment of the elderly.<sup>[49]</sup> None of the studies made their training materials publicly available. Please see Table 3 for details about training content of each study.

**Table 2: Training methods and duration for CVD and its risk factors management for CHWs in LMICs**

Study	Training details	Duration of training program	Methods of training (workshop, online)
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Non-invasive screening of cardiovascular risk score	Hours of training not reported (2 weeks training over 4 months)	Lectures and interactive lessons. On-site training for anthropometric measurements, BMI and CVD risk score calculation
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Hypertension knowledge and basic skills practices development	16.5 hours (11 sessions fortnightly over 6 months)	Lectures and practical sessions
Fatmah F, 2014 <sup>[49]</sup>	Obesity and hypertension knowledge BMI metric tool measurements	11 hours (2 days)	Lectures and interactive sessions. On-site training for BMI metric tool measurements.
Ku GM V et al, 2014 <sup>[53]</sup>	Diabetes knowledge and basic skills practices development	32 hours	Lectures, two-way demonstrations, hands-on workshops
Nishtar S et al, 2007 <sup>[54]</sup>	Cardiovascular disease prevention	6 hours	Interactive training workshops
Sangprasert P, 2011 <sup>[47]</sup>	Hypertension knowledge and basic skills practices development	Not reported	Lectures and group discussions
Seyed Emami R et al, 2011 <sup>[50]</sup>	Health education about physical activity	2.5 hours (3 weekly sessions)	Lectures, group discussions
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Hypertension knowledge and basic skills practices development	40 hours (16 sessions, over 4 months)	Lectures and group discussion, problem-based learning e-learning and online support Community-based application Assignments and self-evaluations

**Table 3: Training content for CVD and its risk factors management for CHWs in LMICs**

	Knowledge	Skills
<b>Abrahams-Gessel S et al, 2015<sup>[51]</sup></b>	Cardiovascular disease and its risk factors	Blood pressure measurement Weight and height measurements and BMI calculation Obtaining a 5-year CVD risk score using a "Risk scoring Chart"
<b>Da Silva SSB E et al, 2010<sup>[48]</sup></b>	Hypertension and its treatment, Epidemiological data regarding hypertension to clarify its problem, Healthy lifestyle promotion, Treatment adherence and its importance	N/A
<b>Fatmah F, 2014<sup>[49]</sup></b>	Obesity risk factors and consequences Balanced Nutrition and Salt restriction Physical activity for the elderly Hypertension and its risk factors	BMI meter tool measurements for nutritional status assessment
<b>Ku GM V et al, 2014<sup>[53]</sup></b>	Diabetes diagnosis and management Foot care Diabetic diet and dietary counselling Physical activity	Anthropometric measurements (weight, height, waist and hip circumference), BMI and waist-hip ratio calculation and their interpretation. Blood pressure and blood glucose measurement, Psychosocial skills development (active listening, patient and family empowerment and social mobilization)
<b>Nishtar S et al, 2007<sup>[54]</sup></b>	Blood pressure measurement importance and desired frequency, Healthy life style and its role in preventing CVD and its complications	N/A
<b>Sangprasert P, 2011<sup>[47]</sup></b>	Health promotion and health education practices Healthy dietary habits Physical activity Relaxation skills	Blood pressure measurement Weight, height and waist and hip circumference measurements BMI calculation and its interpretation
<b>Seyed Emami R et al, 2011<sup>[50]</sup></b>	Food and nutrition Healthy eating and physical activity Current challenges for physical activity Overcoming barriers for a healthy lifestyle adoption	N/A
<b>Sranacharoenpong K et al, 2012<sup>[52]</sup></b>	Healthy dietary habits and providing proper dietary recommendations Physical activity and motivating at-risk population	Weight, height and waist circumference measurements and their interpretation

**Impact of the training on knowledge and skills**

All the studies assessed the knowledge<sup>[47-54]</sup> and five of them assessed knowledge and skills<sup>[47 49 51-53]</sup> before and after the training sessions. In addition, two studies evaluated the effect of training at 3-6 months<sup>[51]</sup> and 8 months after the intervention study.<sup>[52]</sup> Pre- and post-training mean scores were reported by all studies as a measure of effectiveness of training. Of the eight studies included in the review, we could use scores from seven studies; the eighth study<sup>[47]</sup> could not be included in the figure as the measure of test scores was not described. All the studies showed increase in the knowledge mean scores among CHWs pre- and post-training ranging from 3%<sup>[48]</sup> to 40%,<sup>[51]</sup> with six of the studies reporting statistically significant difference between the base knowledge level and post-training knowledge level of the CHWs.<sup>[47 49 50 52-54]</sup> In the two studies (including five sites) which assessed the knowledge post-intervention, the knowledge level of CHWs in Bangladesh did not change, the CHWs in Guatemala<sup>[51]</sup> showed an average increase of 11%, and the scores of CHWs in Mexico, South Africa<sup>[51]</sup> and Thailand<sup>[52]</sup> decreased over time. Figure 2 provides details regarding the change of the test scores and reported statistical significance of the pre-post training knowledge scores. One study assessed the counselling skills of the participant CHWs at base-line, one month and two-months post-training through field visits.<sup>[49]</sup> In addition, two projects used qualitative methods to assess the potential challenges and enablers of CHW training programs, through observation, interviews, and focus group discussions.<sup>[51 56 57]</sup>

CHWs preferred a minimum 2-week training program with interactive classes. Since this was the first time many CHWs were offered training in such a setting, it wasn't clear to them what to expect from the training session or workshops. Language barrier was another challenge, as the training manual was written in the local language, while the medium of instruction was in English, this made it difficult for the CHWs to link the manual with the verbal instructions provided. Barriers experienced while working in the field included gender issues such as taking anthropometric measurements of the opposite sex, lack of trust among community to share their health concerns with CHWs, safety and other cultural issues.<sup>[51 58 59]</sup> In addition, heavy workload, underestimation of the time required to carry out the work and low remuneration provided were other barriers raised by CHWs. In terms of

frequency of access to learning materials and satisfaction with the training program (including length, methods, and usefulness of the program, computer skills and using electronic and paper-based materials), CHWs seemed satisfied with the content of training program, and the assignments. However, about 46% did not feel that computer skills were easy to learn.

### Study quality

One out of the eight studies was a randomised controlled trial,<sup>[52]</sup> while the others were pre- and post-observational studies. The CHW retention rates varied across the studies from 77%<sup>[51]</sup> to 88%<sup>[53]</sup> with two studies retaining 100% of CHWs,<sup>[48 52]</sup> and one study not reporting CHW turnover during the study period.<sup>[47]</sup> Detailed information about CHWs,<sup>[54]</sup> trainers,<sup>[47 52]</sup> development of the training program<sup>[48 54]</sup> and process of knowledge evaluation<sup>[54]</sup> was not reported in some studies. The quality of all included studies was assessed using Effective Public Health Practice Project's (EPHPP) Quality Assessment Tool.<sup>[46]</sup> Evaluated across six quality domains, each study was assessed with the potential of an overall rating of weak, moderate or strong. The quality of two studies were rated moderate.<sup>[50 52]</sup> The others were rated weak. Please see Table 4 for details of the quality assessment for each of the six quality domains.

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**Table 4: Assessment of the quality of included studies using the EPHPP tool<sup>[46]</sup>**

Study	Selection bias*1	Study Design*2	Confounders*3	Blinding*4	Data Collection Methods*5	Withdrawals and Drop-outs*6	Overall Rating
Abrahams-Gessel S et al, 2015 <sup>[51]</sup>	Weak	Moderate	Weak	Weak	Moderate	Weak	<b>Weak</b>
Da Silva SSB E et al, 2010 <sup>[48]</sup>	Moderate	Moderate	Moderate	Weak	Weak	Moderate	<b>Weak</b>
Fatmah F, 2014 <sup>[49]</sup>	Moderate	Weak	Weak	Weak	Moderate	Weak	<b>Weak</b>
Ku GM V et al, 2014 <sup>[53]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Strong	<b>Weak</b>
Nishtar S et al, 2007 <sup>[54]</sup>	Weak	Moderate	Not reported (weak)	Weak	Weak	Weak	<b>Weak</b>
Sangprasert P, 2011 <sup>[47]</sup>	Moderate	Moderate	Moderate	Weak	Moderate	Weak	<b>Weak</b>
Seyed Emami R et al, 2011 <sup>[50]</sup>	Strong	Weak	Strong	Weak	Strong	Moderate	<b>Moderate</b>
Sranacharoenpong K et al, 2012 <sup>[52]</sup>	Strong	Strong	Moderate	Weak	Strong	Strong	<b>Moderate</b>

1. Likelihood of the participants to be representing the target population.  
2. The likelihood of bias due to allocation process in the study design.  
3. Effect of variables associated with the intervention and causally related to the outcome of interest.  
4. Likelihood of protection against reporting bias.  
5. Reliability and validity of outcome measures.  
6. Assessment of the description of numbers and reasons for withdrawals and drop-outs.

## DISCUSSION

In this review, we assessed the effectiveness of training CHWs for the prevention and management of CVD and its risk factors. We reviewed eight studies, which focussed on CVD, hypertension, diabetes or physical activity. The limited evidence available from this review demonstrates that CHWs with low-levels of formal education can be trained effectively for CVD and risk factor prevention and management. The results of this review need to be assessed in light of the study quality which was rated as weak to moderate using the EPHPP tool. The knowledge and skill-set of CHWs improved in the immediate post training period for all studies and varied in performance in the 6-8 months after the initiation of the intervention. The limited qualitative data from two studies<sup>[51 56 57]</sup> indicates that interactive training, hands-on workshops and case scenarios were preferred over traditional didactic training. Training sessions adapted to local culture and delivered in the local language were found to be easier for the CHWs to understand and retain. Since measurement of cardiovascular risk factors involves taking blood pressure, height, weight and waist measurements in both men and women, understanding the cultural norms was an essential component to deliver the training to CHWs who were women in most studies.

Regardless of the baseline knowledge scores of the trained CHWs, most of the post-training knowledge scores ranged between 70 and 80%. The two studies<sup>[51 52]</sup> that measured knowledge at 6-8 months post-training showed that the majority of CHWs had a small decline in their scores; demonstrating their retention of knowledge to certain degree over a period of six to eight months. Further research is needed to assess the ideal interval for re-training to ensure long term improvement in knowledge and consequent improvement in health outcomes for the community. A review of CHW training for maternal and child health related conditions<sup>[60]</sup> and mental health<sup>[61]</sup> found that without re-training, acquired skills and knowledge are lost over time. Different time intervals of refresher training were found to be effective to retain the capability and performance of CHWs. Various studies conducted in different countries had diverse experiences using monthly, quarterly and yearly refresher trainings to help CHWs maintain consistent performance<sup>[60]</sup>. While training is an



important determinant of performance, other factors related to training include recognition of competence in skills to perform related tasks. Hence, contemporary CHW training programs now include competency based training rather than the traditional knowledge based training. Recent reviews on task-shifting from physicians to non-physicians for management of CVD and other NCDs in LMIC have found that training, close supervision and feedback are essential for the success of task-shifting interventions.<sup>[25 62]</sup> Training of CHWs occurs through formal schooling, in-service training and on-the-job experience; and these, coupled with the working environment, supervision, motivation, career progression, and incentives determine the long term effectiveness and performance of CHWs,<sup>[63]</sup> which ultimately impacts the health of individuals in the community.

While the focus of this paper was knowledge change, results from some of these studies have demonstrated the effectiveness of CHW training on health outcomes. For instance, trained CHWs in Bangladesh, Guatemala, Mexico and South Africa could correctly identify individuals at high risk of CVD <sup>[51]</sup>, and CHW screening had high concordance with health professionals. In Indonesia, the Posbindu health workers were successful in motivating the elderly to actively engage with the health care providers and have better access to health care. <sup>[49]</sup> In the Philippines, Barangay health workers trained in diabetes care, were instrumental in improving Glycaemic control among diabetics. <sup>[53]</sup> In Pakistan, trained CHWs were successful in educating communities in cardiovascular risk factors. <sup>[54]</sup>

Over the last ten years, there have been several studies involving CHWs for the prevention and management of CVD risk factors via complex multifaceted interventions in LMICs.<sup>[64 65]</sup> While most studies that involve CHWs include a component of training, none of them report the content, length or effectiveness of training on CHWs. Studies from South Africa,<sup>[66 67]</sup> Pakistan,<sup>[68]</sup> India,<sup>[69-71]</sup> China,<sup>[72]</sup> Dominic Republic,<sup>[73]</sup> Guatemala,<sup>[74]</sup> Thailand,<sup>[75]</sup> Mexico<sup>[76]</sup> and the Mexican-US border<sup>[77]</sup> have shown innovative ways of involving CHWs for the prevention and control of CVD and its risk factors. However, these studies did not measure the impact of training on CHW knowledge and skill set.

Testing knowledge and skills via pre- and post-training tests does not necessarily reflect the trainee's competence and successful demonstration of behaviour change or change in capability. Standardized measures need to be considered for quality and efficacy assessment of CHW training programs. Few standardized tools and methods for training evaluation and effectiveness assessment are available<sup>[78-81]</sup> which focus on the short-term and long-term outcomes of the training. Kirkpatrick's Four-Level Training Evaluation Model<sup>[81]</sup> is one such method which is based on evaluating the trainees' reaction to the training program, improvement in knowledge, the degree to which they apply the knowledge, and the long-term outcomes. Kaufman's 5 Levels of Evaluation<sup>[80]</sup> is another standard for evaluating the effectiveness of training which evaluates the training design, materials and resources used and the final outcome on the whole community and the trainee. Using standardized methods of evaluation allows better comparison and interpretation of the data.

This review was not able to explain the difference in the knowledge gained by CHWs within and across knowledge, and the variability of the training duration and contextual factors. For instance, the knowledge score of the CHWs in South Africa, Guatemala and Bangladesh were higher than the scores of CHWs in Mexico, even though all four sites were part of the same trial with the same training protocol.<sup>[51]</sup> Hence, research is needed to understand the training needs of the; CHWs and community requirements for the successful roll out of CHW focused interventions on CVD prevention and control. Randomised controlled trials involving CHWs should provide details about the CHW characteristics, curriculum development, training provided and impact of the training, and these should ideally be costed. Mixed methods studies would give a better understanding of the challenges involved with implementing training programs for CHWs and provide evidence for best practice. Training design should consider the background education and prior training received, current roles of the CHWs and how the new skills should complement this role. Training should include demonstration, simulation and on the job supervision to improve confidence of CHWs with their newly learned skills. Communication skills training should focus on changing social norms and behaviours and encouraging the community to work on local fears and myths. CHW attitudes, expression of respect, responsibility and concern should be addressed in training design to assure

development of appropriate relationship between the CHWs and the patients and rest of the community.<sup>[82]</sup> With the available mobile conferencing platforms, follow-up training can be provided to many trainees at a time, remotely as well. Training should be provided onsite where CHWs perform their roles, evidence suggest that onsite training tends to cost less and cause less disruption of the routine functioning of health services, compared to offsite training.<sup>[83]</sup> Better training programs alone will not solve the problems related to opportunities for career growth and professional development via continuing education; the chance to move to the next level within the health system would help motive CHWs to stay in the workforce.<sup>[60]</sup> Attention needs to be paid to CHW remuneration and career development as these are noted challenges affecting the retention of trained CHWs in the workforce. Governments should adopt innovative national planning and provide suitable financial and legal support to ensure the sustainability of implemented programs.<sup>[84-87]</sup> Researchers should consider making the tool kits and resources for CVD management publicly available to other researchers and governments.

Even though our search included all the CHW terminologies used by the WHO and recent reviews on CHWs,<sup>[44]</sup> we may have missed some studies. After expanding the search to include all languages and extending the time limit to the end of 2016, our search identified only 8 studies. The insufficient reporting of study details such as CHWs characteristics, training site, and trainer's profiles led to limited understanding of the contextual factors that influenced the training. Most of the studies were not controlled trials, which made it difficult to investigate the effect of potential confounders. This review included CHWs who were part of the health system and those that volunteered their services. We acknowledge that there is a difference between health volunteers and CHWs,<sup>[88]</sup> but since the overall aim of the paper was to evaluate the effectiveness of training programs, remuneration would have little impact on the change in knowledge and skill set. Despite these limitations, our review indicates that training CHWs about CVD and its risk factors is plausible in LMICs.

In conclusion, this review demonstrates that there is not much information about CHW training for CVD prevention and control in LMICs. While the results of the eight included studies suggest CHWs

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3 can be trained effectively for CVD prevention and management, this finding would likely vary  
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5 depending on context, given the numerous differences between studies (e.g., populations, settings and  
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7 programs), and the weak quality of six of the eight studies. Well conducted mixed methods studies are  
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9 needed to provide reliable evidence about the effectiveness and cost-effectiveness of training  
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11 programs for CVD prevention and management.  
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**Ethics approvals**

An ethics committee approval was not required for this paper as it involved secondary analysis of publicly available data.

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**Conflict of Interest**

None declared

**Author Contributions**

BP drafted the protocol under the supervision of RJ. BP and MA performed the search, extracted the data, and contributed towards the interpretation of the results. MA wrote the first draft. RJ conceived the research question, supervised the review and approved the final version of the manuscript. DP and SA provided critical input towards the manuscript. All the authors reviewed the final draft.

**Data sharing statement**

All the data is available in the systematic review and supplementary files. No extra data is available

**Figure 1. Flow Diagram for systematic review process**

**Figure 2. Change in knowledge scores among CHWs**

For peer review only

References

1. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;**3**(11):e442 doi: 10.1371/journal.pmed.0030442[published Online First: Epub Date]].

2. Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. 1971. Milbank Q 2005;**83**(4):731-57 doi: 10.1111/j.1468-0009.2005.00398.x[published Online First: Epub Date]].

3. Cardiovascular diseases (CVDs). World Health Organization. Fact sheet. Secondary Cardiovascular diseases (CVDs). World Health Organization. Fact sheet 2016. <http://www.who.int/mediacentre/factsheets/fs317/en/>.

4. Celermajer DS, Chow CK, Marijon E, et al. Cardiovascular disease in the developing world: prevalences, patterns, and the potential of early disease detection. Journal of the American College of Cardiology 2012;**60**(14):1207-16 doi: 10.1016/j.jacc.2012.03.074[published Online First: Epub Date]].

5. Maher D, Ford N, Unwin N. Priorities for developing countries in the global response to non-communicable diseases. Global Health 2012;**8**:14 doi: 10.1186/1744-8603-8-14[published Online First: Epub Date]].

6. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. Circulation 1998;**97**(6):596-601

7. Crouse HL, Macias CG, Cruz AT, et al. Utilization of a mobile medical van for delivering pediatric care in the bateys of the Dominican Republic. International Journal of Emergency Medicine 2010;**3** (4):227-32 doi: <http://dx.doi.org/10.1007/s12245-010-0198-4>[published Online First: Epub Date]].

8. Scheffler RM, Liu JX, Kinfu Y, et al. Forecasting the global shortage of physicians: an economic-and needs-based approach. Bulletin of the World Health Organization 2008;**86**(7):516-23B

9. The World Health Report 2006: Working together for health: World Health Organization, 2006.

10. Sharma DC. India still struggles with rural doctor shortages. The Lancet 2015;**386**(10011):2381-82

11. Chen L, Evans T, Anand S, et al. Human resources for health: overcoming the crisis. The Lancet 2004;**364**(9449):1984-90

12. Lehmann U, Sanders D. Community health workers: what do we know about them. The state of the evidence on programmes, activities, costs and impact on health outcomes of using community health workers Geneva: World Health Organization 2007:1-42

13. Vaughan K, Kok MC, Witter S, et al. Costs and cost-effectiveness of community health workers: evidence from a literature review. Hum Resour Health 2015;**13**(1):71 doi: 10.1186/s12960-015-0070-y[published Online First: Epub Date]].

14. Neupane D, Kallestrup P, McLachlan CS, et al. Community health workers for non-communicable diseases. Lancet Glob Health 2014;**2**(10):e567 doi: 10.1016/S2214-109X(14)70303-1[published Online First: Epub Date]].

15. Gilmore B, McAuliffe E. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low-and middle-income countries: a systematic review. BMC Public Health 2013;**13**(1):1

16. Tran N, Portela A, de Bernis L, et al. Developing Capacities of Community Health Workers in Sexual and Reproductive. Maternal, Newborn 2014

17. Lawn J, Kerber K. Opportunities for Africa's newborns: practical data policy and programmatic support for newborn care in Africa. 2006

18. Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database Syst Rev 2010(3):CD004015 doi: 10.1002/14651858.CD004015.pub3[published Online First: Epub Date]].

19. Lassi ZS, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. Cochrane Database Syst Rev

- 2015;**3**:CD007754 doi: 10.1002/14651858.CD007754.pub3[published Online First: Epub Date]].
20. Mwai GW, Mburu G, Torpey K, et al. Role and outcomes of community health workers in HIV care in sub-Saharan Africa: a systematic review. *Journal of the International AIDS Society* 2013;**16**(1)
  21. Huicho L, Scherpbier RW, Nkowane AM, et al. How much does quality of child care vary between health workers with differing durations of training? An observational multicountry study. *The Lancet* 2008;**372**(9642):910-16
  22. Hermann K, Van Damme W, Pariyo GW, et al. Community health workers for ART in sub-Saharan Africa: learning from experience—capitalizing on new opportunities. *Human resources for health* 2009;**7**(1):1
  23. Schneider H, Hlophe H, van Rensburg D. Community health workers and the response to HIV/AIDS in South Africa: tensions and prospects. *Health policy and Planning* 2008;**23**(3):179-87
  24. Simon S, Chu K, Frieden M, et al. An integrated approach of community health worker support for HIV/AIDS and TB care in Angonia district, Mozambique. *BMC International Health and Human Rights* 2009;**9**(1):1
  25. Joshi R, Alim M, Kengne AP, et al. Task shifting for non-communicable disease management in low and middle income countries—a systematic review. *PloS one* 2014;**9**(8):e103754
  26. Lehmann U, Van Damme W, Barten F, et al. Task shifting: the answer to the human resources crisis in Africa? *Hum Resour Health* 2009;**7**:49 doi: 10.1186/1478-4491-7-49[published Online First: Epub Date]].
  27. Joshi R, Santo, K., Redfern, K. Task shifting for cardiovascular disease management: What can we learn from other models? *Journal of Cardiology and Therapy* 2014;**1**(5):65-73
  28. Abegunde DO, Shengelia B, Luyten A, et al. Can non-physician health-care workers assess and manage cardiovascular risk in primary care? *Bull World Health Organ* 2007;**85**(6):432-40
  29. Raphael JL, Rueda A, Lion KC, et al. The role of lay health workers in pediatric chronic disease: a systematic review. *Acad Pediatr* 2013;**13**(5):408-20 doi: 10.1016/j.acap.2013.04.015[published Online First: Epub Date]].
  30. Balcazar HG, de Heer HD. Community health workers as partners in the management of non-communicable diseases. *Lancet Glob Health* 2015;**3**(9):e508-9 doi: 10.1016/S2214-109X(15)00142-4[published Online First: Epub Date]].
  31. Mohan V, Deepa M, Pradeepa R, et al. Prevention of diabetes in rural India with a telemedicine intervention. *J Diabetes Sci Technol* 2012;**6**(6):1355-64
  32. Cappuccio FP, Kerry SM, Micah FB, et al. A community programme to reduce salt intake and blood pressure in Ghana [ISRCTN88789643]. *BMC public health* 2006;**6**(1):13
  33. Jafar TH, Islam M, Hatcher J, et al. Community based lifestyle intervention for blood pressure reduction in children and young adults in developing country: cluster randomised controlled trial. *BMJ* 2010;**340**:c2641
  34. Coleman R, Gill G, Wilkinson D. Noncommunicable disease management in resource-poor settings: a primary care model from rural South Africa. *Bull World Health Organ* 1998;**76**(6):633-40
  35. Farzadfar F, Murray CJ, Gakidou E, et al. Effectiveness of diabetes and hypertension management by rural primary health-care workers (Behvarz workers) in Iran: a nationally representative observational study. *Lancet* 2012;**379**(9810):47-54 doi: 10.1016/S0140-6736(11)61349-4[published Online First: Epub Date]].
  36. Alem A, Jacobsson L, Hanlon C. Community-based mental health care in Africa: mental health workers' views. *World Psychiatry* 2008;**7**(1):54-7
  37. Redick C, Dini H. The current state of CHW training programs in Sub-Saharan Africa and South Asia: What we know what we dont know and what we need to do. 2014
  38. Waldman R. Health programming for rebuilding states: a briefing paper. 2007



39. Ryabov I. Cost-effectiveness of Community Health Workers in controlling diabetes epidemic on the U.S.-Mexico border. *Public Health* 2014;**128**(7):636-42 doi: <http://dx.doi.org/10.1016/j.puhe.2014.05.002>[published Online First: Epub Date]] .

40. Pallas SW, Minhas D, Pérez-Escamilla R, et al. Community health workers in low-and middle-income countries: what do we know about scaling up and sustainability? *American journal of public health* 2013;**103**(7):e74-e82

41. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of internal medicine* 2009;**151**(4):264-69

42. Lariosa T. The role of community health workers in malaria control in the Philippines. *The Southeast Asian journal of tropical medicine and public health* 1991;**23**:30-35

43. Sharma R, Webster P, Bhattacharyya S. Factors affecting the performance of community health workers in India: a multi-stakeholder perspective. *Global health action* 2014;**7**

44. Olaniran A, Smith H, Unkels R, et al. Who is a community health worker?—a systematic review of definitions. *Global health action* 2017;**10**(1):1272223

45. The World Bank. *Country and Lending Groups*, 2016.

46. Thomas H. *Quality assessment tool for quantitative studies*. Effective Public Health Practice Project McMaster University, Toronto 2003

47. Sangprasert P. The effects of a training program for the development of hypertension knowledge and basic skills practice (HKBSP) for Thai community healthcare volunteers. *Siriraj Medical Journal* 2011;**63**(5):163-67

48. Da Silva SSBE, Colosimo FC, Pierin AMG. [The effect of educational interventions on nursing team knowledge about arterial hypertension]. *Revista Da Escola de Enfermagem Da Usp* 2010;**44**(2):488-96

49. Fatmah F. Training Effect on Improving Cadres’ Knowledge and Skills of Obesity and Hypertension in Older People. *Makara Journal of Health Research* 2014:49-54

50. Seyed Emami R, Eftekhar Ardebili H, Golestan B. Effect of a health education intervention on physical activity knowledge, attitude and behavior in health volunteers. *Journal of hayat* 2011;**16**(3):48-55

51. Abrahams-Gessel S, Denman CA, Montano CM, et al. The training and fieldwork experiences of community health workers conducting population-based, noninvasive screening for CVD in LMIC. *Global Heart* 2015;**10** (1):45-54 doi: <http://dx.doi.org/10.1016/j.gheart.2014.12.008>[published Online First: Epub Date]] .

52. Sranacharoenpong K, Hanning RM. Diabetes prevention education program for community health care workers in Thailand. *Journal of Community Health* 2012;**37** (3):610-18

53. Ku GM V , G K. Integrating chronic care with primary care activities: enriching healthcare staff knowledge and skills and improving glycemic control of a cohort of people with diabetes through the First Line Diabetes Care Project in the Philippines. *Global health action* 2014;**7**(25286)

54. Nishtar S, Badar A, Kamal MU, et al. The Heartfile Lodhran CVD prevention project--end of project evaluation. *Promotion & education* 2007;**14** (1):17-27

55. Salter D, Richards L, Carey T. The ‘T5’ Design Model: An Instructional Model and Learning Environment to Support the Integration of Online and Campus - Based Courses. *Educational Media International* 2004;**41**(3):207-18

56. Sranacharoenpong K, Hanning RM. Developing a diabetes prevention education programme for community health-care workers in Thailand: formative findings. *Primary Health Care Research & Development* 2011;**12** (4):357-69 doi: <http://dx.doi.org/10.1017/S146342361100020X>[published Online First: Epub Date]] .

57. Sranacharoenpong K, Hanning RM, Sirichakwal PP, et al. Process and outcome evaluation of a diabetes prevention education program for community healthcare workers in Thailand. *Education for health (Abingdon, England)* 2009;**22** (3):335

58. Gaziano TA, Abrahams-Gessel S, Denman CA, et al. An assessment of community health workers' ability to screen for cardiovascular disease risk with a simple, non-invasive risk assessment instrument in Bangladesh, Guatemala, Mexico, and South Africa: an observational study. *The Lancet Global Health* 2015;**3**(9):e556-e63
59. Abrahams-Gessel S, Denman CA, Montano CM, et al. Lessons from Training and Supervision of Community Health Workers conducting non-invasive, population-based screening for Cardiovascular Disease in Four Communities in Low and Middle-Income Settings: Implications for Scaling Up. *Global heart* 2015;**10**(1):39
60. Bhutta ZA, Lassi ZS, Pariyo G, et al. Global experience of community health workers for delivery of health related millennium development goals: a systematic review, country case studies, and recommendations for integration into national health systems. *Global Health Workforce Alliance* 2010;**1**:249-61
61. Armstrong G, Kermode M, Raja S, et al. A mental health training program for community health workers in India: impact on knowledge and attitudes. *International journal of mental health systems* 2011;**5**(1):17
62. Ogedegbe G, Gyamfi J, Plange-Rhule J, et al. Task shifting interventions for cardiovascular risk reduction in low-income and middle-income countries: a systematic review of randomised controlled trials. *BMJ open* 2014;**4**(10) doi: 10.1136/bmjopen-2014-005983[published Online First: Epub Date] ].
63. Rowe AK, de Savigny D, Lanata CF, et al. How can we achieve and maintain high-quality performance of health workers in low-resource settings? *The Lancet*; **366**(9490):1026-35 doi: 10.1016/S0140-6736(05)67028-6[published Online First: Epub Date] ].
64. Kamath DY, Xavier D, Gupta R, et al. Rationale and design of a randomized controlled trial evaluating community health worker-based interventions for the secondary prevention of acute coronary syndromes in India (SPREAD). *American Heart Journal* 2014;**168** (5):690-97 doi: <http://dx.doi.org/10.1016/j.ahj.2014.07.029>[published Online First: Epub Date] ].
65. van de Vijver S, Oti S, Addo J, et al. Review of community-based interventions for prevention of cardiovascular diseases in low- and middle-income countries. *Ethnicity & Health* 2012;**17**(6):651-76 doi: <http://dx.doi.org/10.1080/13557858.2012.754409>[published Online First: Epub Date] ].
66. Surka S, Edirippulige S, Steyn K, et al. Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers. *International Journal of Medical Informatics* 2014;**83**(9):648-54 doi: <http://dx.doi.org/10.1016/j.ijmedinf.2014.06.008>[published Online First: Epub Date] ].
67. Botes AS, Majikela-Dlangamandla B, Mash R. The ability of health promoters to deliver group diabetes education in South African primary care. *African Journal of Primary Health Care and Family Medicine* 2013;**5**(1)
68. Khan M, Kamal AK, Islam M, et al. Can Trained Field Community Workers Identify Stroke Using a Stroke Symptom Questionnaire as well as Neurologists?: Adaptation and Validation of a Community Worker Administered Stroke Symptom Questionnaire in a Peri-urban Pakistani Community. *Journal of Stroke and Cerebrovascular Diseases* 2015;**24**(1):91-99
69. Balagopal P, Kamamma N, Patel TG, et al. A community-based participatory diabetes prevention and management intervention in rural India using community health workers. *Diabetes Educ* 2012;**38**(6):822-34 doi: <http://dx.doi.org/10.1177/0145721712459890>[published Online First: Epub Date] ].
70. Xavier D, Gupta R, Kamath D, et al. Community health worker-based intervention for adherence to drugs and lifestyle change after acute coronary syndrome: a multicentre, open, randomised controlled trial. *The Lancet Diabetes & Endocrinology*; **4**(3):244-53 doi: 10.1016/S2213-8587(15)00480-5[published Online First: Epub Date] ].

71. Joshi R, Chow CK, Raju PK, et al. The Rural Andhra Pradesh Cardiovascular Prevention Study (RAPCAPS): a cluster randomized trial. *Journal of the American College of Cardiology* 2012;**59**(13):1188-96

72. Dongbo F, Hua F, McGowan P, et al. Implementation and quantitative evaluation of chronic disease self-management programme in Shanghai, China: randomized controlled trial. *Bulletin of the World Health Organization* 2003;**81**(3):174-74 1p

73. West-Pollak A, Then EP, Podesta C, et al. Impact of a novel community-based lifestyle intervention program on type 2 diabetes and cardiovascular risk in a resource-poor setting in the Dominican Republic. *International Health* 2014;**6**(2):118-24 doi: <http://dx.doi.org/10.1093/inthealth/ih039>[published Online First: Epub Date] | .

74. Micikas M, Foster J, Weis A, et al. A community health worker intervention for diabetes self-management among the Tz'utujil Maya of Guatemala. *Health Promotion Practice* 2015;**16**(4):601-08

75. Saranrittichai K, Senarak W, Promthet S, et al. Health behavior after a multiprofessional intervention and training for ongoing volunteer-based community health programme intervention in the North-East of Thailand: what changed and what not? *Asian Pacific Journal of Cancer Prevention* 2012;**13**(9):4801-05

76. Denman CA, Rosales C, Cornejo E, et al. Evaluation of the community-based chronic disease prevention program Meta Salud in Northern Mexico, 2011-2012. *Preventing Chronic Disease* 2014;**11**:E154 doi: <http://dx.doi.org/10.5888/pcd11.140218>[published Online First: Epub Date] | .

77. Cornejo E, Denman CA, Sabo S, et al. Scoping review of community health worker/promotora-based chronic disease primary prevention programs on the US-Mexico border. *alamo colson edu mx* 2011;**8085**

78. Alvarez K, Salas E, Garofano CM. An integrated model of training evaluation and effectiveness. *Human resource development Review* 2004;**3**(4):385-416

79. Wang GG, Wilcox D. Training evaluation: knowing more than is practiced. *Advances in Developing Human Resources* 2006;**8**(4):528-39

80. Kaufman R, Keller JM. Levels of evaluation: beyond Kirkpatrick. *Human Resource Development Quarterly* 1994;**5**(4):371-80

81. Bates R. A critical analysis of evaluation practice: the Kirkpatrick model and the principle of beneficence. *Evaluation and program planning* 2004;**27**(3):341-47

82. Perry H, Crigler L. Developing and strengthening community health worker programs at scale. A reference guide and case studies for program managers and policymakers. 2013

83. Ritchie LMP, Schull MJ, Martiniuk AL, et al. A knowledge translation intervention to improve tuberculosis care and outcomes in Malawi: a pragmatic cluster randomized controlled trial. *Implementation Science* 2015;**10**(1):1

84. Kok MC, Dieleman M, Taegtmeier M, et al. Which intervention design factors influence performance of community health workers in low-and middle-income countries? A systematic review. *Health policy and planning* 2015;**30**(9):1207-27

85. Abbey M, Bartholomew LK, Nonvignon J, et al. Factors related to retention of community health workers in a trial on community-based management of fever in children under 5 years in the Dangme West District of Ghana. *International health* 2014;**6**(2):99-105

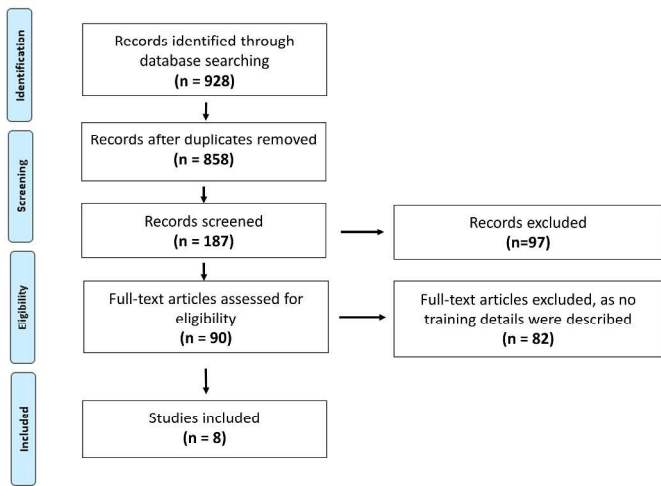
86. Bhattacharyya K, Winch P, LeBan K, et al. Community Health Worker Incentives and Disincentives: How They Affect Motivation, Retention, and Sustainability. Published by the Basic Support for Institutionalizing Child Survival Project (BASICS II) for the United States Agency for International Development. Arlington, Virginia.

87. Research on community-based health workers is needed to achieve the sustainable development goals. *Bulletin of the World Health Organization*. November 2016 ed, 2016:786-86.

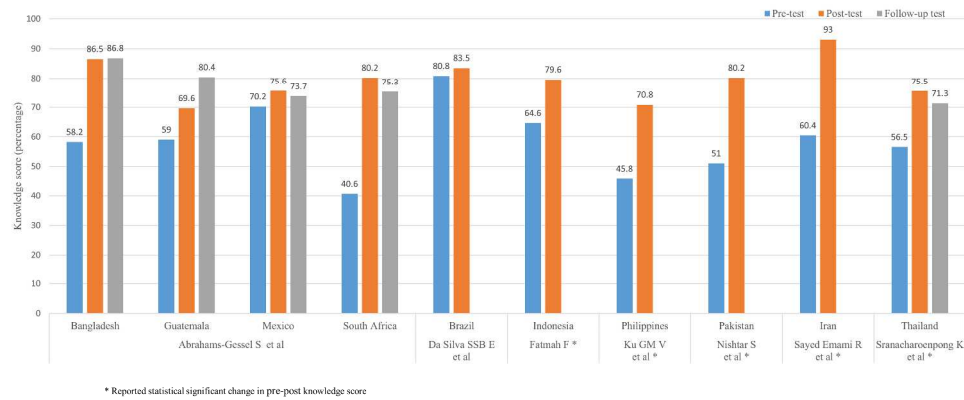
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3 88. Vareilles G, Pommier J, Marchal B, et al. Understanding the performance of community health  
4 volunteers involved in the delivery of health programmes in underserved areas: a realist  
5 synthesis. Implementation Science 2017;**12**(1):22  
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**APPENDIX 1**

Free text terms used in the databases on the OVID platform (Medline, Global Health, ERIC, Embase):

**CHW Group (Population)**

1. (Communit\* health\* adj3 (work\* or staff or employee\* or provider\* or distributor\* or surveyor\* or assistant\* or promoter\* or facilitator\* or agent\*)).tw.
2. (Non-physician health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
3. CHW.tw.
4. LHW.tw.
5. (Lay health\* adj3 (work\* or staff or employee\* or provider\*)).tw.
6. Volunteer health\* work\*.tw.
7. Voluntary health\* work\*.tw.
8. Promotoras de salud.tw.
9. (rural health adj3 (auxiliar\* or motivator\*)).tw.
10. Traditional midwi\*.tw.
11. TBA.tw.
12. Traditional birth attendant\*.tw.
13. Health\* promoter\*.tw.
14. Basic health\* work\*.tw.
15. Communit\* nutrition work\*.tw.
16. Communit\* resource person.tw.
17. (Female adj3 (multipurpose health\* work\* or volunteer\*)).tw.
18. (Maternal and child health\* work\*).tw.
19. Mother coordinator\*.tw.
20. Outreach educator\*.tw.
21. Paramedic\* work\*.tw.
22. (Village health\* adj3 (work\* or helper\* or guide\*)).tw.
23. Shasthyo Sebikas.tw
24. ASHA.tw
25. Female community health volunteer\*.tw
26. Community-based health worker\*.tw.
27. Beharv\*.tw.
28. Community Care Worker\*.tw.
29. Care Facilitator\*.tw.
30. Community-based reproductive health agents\*.tw.
31. Animatrice de Sante Maternelle\*.tw.
32. Binome de Sante Maternelle\*.tw.

33. Community Health Development Agent\*.tw.
34. Agentes Polivalentes Elementares\*.tw.
35. Community-based Educators\*.tw.
36. Health Extension Worker\*.tw.
37. Health Surveillance Assistant\*.tw.
38. Lay volunteer\*.tw.
39. Shasthyo kormis\*.tw.
40. Community health care practitioners\*.tw.
41. Health assistants\*.tw.
42. Family welfare assistants\*.tw.

**LMIC Group (Population)**

1. LMIC.mp
2. ((Low or middle) adj income countr\*).mp
3. Developing countr\*.mp
4. South East Asia\*.tw
5. Southeast\* Asia\*.mp.
6. Sub-Saharan Africa\*.tw.
7. Sub-Saharan Africa\*.mp.
8. Afghan\*.mp.
9. Benin\*.mp.
10. Burkina\*.mp.
11. Burundi\*.mp.
12. Cambodia\*.mp.
13. Central African Republic\*.mp.
14. Chad\*.mp.
15. Comor\*.mp.
16. Congo\*.mp.
17. Eritrea\*.mp.
18. Ethiopia\*.mp.
19. Gambia\*.mp.
20. Guinea\*.mp.
21. Haiti\*.mp.
22. North Korea\*.mp.
23. Liberia\*.mp.
24. Madagas\*.mp.
25. Malawi\*.mp.
26. Mali\*.mp.
27. Mozambi\*.mp.
28. Nepal\*.mp.
29. Niger\*.mp.
30. Rwanda\*.mp.
31. Sierra Leone\*.mp.
32. Somalia\*.mp.
33. South Sudan\*.mp.
34. Tanzania\*.mp.
35. Togo\*.mp.



36. Uganda\*.mp.
37. Zimbabwe\*.mp.
38. Armenia\*.mp.
39. Bangladesh\*.mp.
40. Bhutan\*.mp.
41. Bolivia\*.mp.
42. Cape Verd\*.mp.
43. Cameroon\*.mp.
44. Cote d'Ivoire.mp.
45. Ivorian.mp.
46. Djibouti\*.mp.
47. Egypt\*.mp.
48. Salvador\*.mp.
49. Georgia\*.mp.
50. Ghana\*.mp.
51. Guatemala\*.mp.
52. Guyan\*.mp.
53. Hondura\*.mp.
54. India\*.mp.
55. Indonesia\*.mp.
56. Kenya\*.mp.
57. Kiribati\*.mp.
58. Kosov\*.mp.
59. Kyrgyz\*.mp.
60. Lao\*.mp.
61. Lesotho\*.mp.
62. Mauritania\*.mp.
63. Micronesia\*.mp.
64. Moldova\*.mp.
65. Morocc\*.mp.
66. Myanmar\*.mp.
67. Burm\*.mp.
68. Nigeria\*.mp.
69. Pakistan\*.mp.
70. Nicaragua\*.mp.
71. Papua New Guinea\*.mp.
72. Philippin\*.mp.
73. Filipino.mp.
74. Samoa\*.mp.
75. Sao Tome\*.mp.
76. Senegal\*.mp.
77. Solomon\*.mp.
78. Sri Lanka\*.mp.
79. Sudan\*.mp.
80. Swazi\*.mp.
81. Syria\*.mp.
82. Tajik\*.mp.
83. Timor\*.mp.
84. Ukrain\*.mp.
85. Uzbek\*.mp.
86. Vanuatu\*.mp.
87. Vietnam\*.mp.
88. West bank.mp.
89. Gaza\*.mp.
90. Yemen\*.mp.
91. Zambia\*.mp.
92. Albania\*.mp.
93. Algeria\*.mp.
94. Angola\*.mp.
95. Azerbaijan\*.mp.
96. Belarus\*.mp.
97. Belize\*.mp.
98. Bosnia\*.mp.
99. Herzegovin\*.mp.
100. Botswana.mp.
101. Batswana.mp.
102. Brazil\*.mp.
103. Bulgaria\*.mp.
104. Chin\*.mp.
105. Colombia\*.mp.
106. Costa Rica\*.mp.
107. Cuba\*.mp.
108. Dominica\*.mp.
109. Ecuador\*.mp.
110. Fiji\*.mp.
111. Gabon\*.mp.
112. Grenad\*.mp.
113. Iran\*.mp.
114. Iraq\*.mp.
115. Jamaica\*.mp.
116. Jordan\*.mp.
117. Kazakh\*.mp.
118. Leban\*.mp.
119. Libya\*.mp.
120. Macedonia\*.mp.
121. Malaysia\*.mp.
122. Maldiv\*.mp.
123. Marshall Island\*.mp.
124. Mauriti\*.mp.
125. Mexic\*.mp.
126. Mongolia\*.mp.
127. Montenegr\*.mp.
128. Namibia\*.mp.
129. Palau\*.mp.
130. Panama\*.mp.
131. Paraguay\*.mp.
132. Peru\*.mp.
133. Romania\*.mp.
134. Serbia\*.mp.
135. South Africa\*.mp.
136. St Lucia\*.mp.
137. (St Vincent and the Grenadines).mp.



- 138. Vincentian.mp.
- 139. Suriname\*.mp.
- 140. Thai\*.mp.
- 141. Tonga\*.mp.
- 142. Tunisia\*.mp.
- 143. Turk\*.mp.
- 144. Tuvalu\*.mp.

**NCD/CVD Group (Intervention)**

- 1. Diabet\*.tw.
- 2. Obes\*.tw.
- 3. Overweight.tw.
- 4. Cardiovascular Disease\*.tw.
- 5. Hypertens\*.tw.
- 6. Non-communicable Disease\*.tw.
- 7. Chronic Disease\*.tw.
- 8. NCD.tw.
- 9. CVD.tw.
- 10. Coronary Heart Disease\*.tw.
- 11. Cerebrovascular disease\*.tw.
- 12. Peripheral arter\* disease\*.tw.
- 13. Rheumatic Heart disease\*.tw.
- 14. Congenital heart disease\*.tw.
- 15. Deep vein thrombosis.tw.
- 16. Deep venous thrombosis.tw.
- 17. Pulmonary embol\*.tw.
- 18. Unhealthy diet.tw.
- 19. Physical inactivity.tw.
- 20. Sedentary lifestyle\*.tw.
- 21. Tobacco.tw.
- 22. Alcohol.tw.
- 23. Hypercholesterol?emia.tw.
- 24. Hyperlipid?emia.tw.

**Training Programs Group (Intervention)**

- 1. ((education\* or train\*) adj2 program\*).tw.

Medical Subject Headings (MeSH) terms used for each database:

Medline

**CHW Group (Population)**

- 26. Community health workers/
- 27. Home health aides/
- 28. Community health services/

**LMIC Group (Population)**

- 145. Developing Countries/
- 146. Asia, Southeastern/

- 147. exp "Africa South of the Sahara"/
- 148. "Democratic People's Republic of Korea"/
- 149. exp Micronesia/

**NCD/CVD Group (Intervention)**

- 25. Chronic Disease/
- 26. Diabetes Mellitus/
- 27. exp Diabetes Mellitus, Type 2/
- 28. exp Obesity/
- 29. Overweight/
- 30. Cardiovascular Diseases/
- 31. exp Heart Diseases/
- 32. exp Vascular Diseases/
- 33. Diet, High-Fat/
- 34. Diet, Western/
- 35. Diet/
- 36. exp "Tobacco Use"/
- 37. exp "Tobacco Use Cessation"/
- 38. exp lipoproteins, ldl/
- 39. exp lipoproteins, vldl/
- 40. Cholesterol, Dietary/
- 41. Hypercholesterolemia/
- 42. Hyperlipidemias/
- 43. exp Obesity/
- 44. Overweight/
- 45. Prediabetic state/
- 46. Sedentary Lifestyle/
- 47. exp Drinking Behavior/
- 48. exp Cerebrovascular Disorders/
- 49. Rheumatic Heart Disease/
- 50. exp Heart Defects, Congenital/

**Training Programs Group (Intervention)**

- 2. "early intervention (education)"/
- 3. health education/
- 4. Education/
- 5. Education, Nonprofessional/
- 6. Program Evaluation/

Global Health

**CHW Group (Population)**

- 26. community health services/
- 27. medical auxiliaries/
- 28. health care workers/
- 29. traditional health services/"C
- 30. traditional birth attendants/

**LMIC Group (Population)**

- 145. developing countries/

146. south east asia/
147. exp indochina/
148. taiwan/
149. "africa south of sahara"/
150. korea democratic people's republic/
151. sudan/
152. exp micronesia/
153. exp "federated states of micronesia"/
154. least developed countries/

#### **NCD/CVD Group (Intervention)**

25. chronic diseases/
26. exp diabetes/
27. type 2 diabetes/
28. obesity/
29. obesity hyperglycaemia syndrome/
30. overweight/
31. exp cardiovascular diseases/
32. exp hypertension/
33. thrombosis/
34. exp heart diseases/
35. exp vascular diseases/
36. diet/
37. physical activity/
38. exp tobacco/
39. tobacco smoking/
40. exp smoking cessation/
41. alcohol intake/
42. hyperlipaemia/
43. hypercholesterolaemia/
44. cholesterol/

#### **Training Programs Group (Intervention)**

2. education/
3. program development/
4. Program effectiveness/
5. Program evaluation/
6. education programmes/
7. health education/
8. medical education/
9. professional education/
10. training/
11. training courses/
12. training officers/

#### **ERIC**

#### **CHW Group (Population)**

26. community health services/
27. home health aides/
28. home programs/

29. exp Paraprofessional Personnel/
30. Lay people/

#### **LMIC Group (Population)**

145. developing nations/

#### **NCD/CVD Group (Intervention)**

25. chronic illness/
26. diabetes/
27. exp body weight/
28. hypertension/
29. exp Physical Activity Level/
30. physical fitness/
31. exp smoking/
32. exp alcohol abuse/
33. eating habits/

#### **Training Programs Group (Intervention)**

2. caregiver training/
3. volunteer training/
4. health education/
5. nonformal education/
6. exp job training/
7. professional training/
8. "Institutes (Training Programs)"/
9. Professional development/
10. Professional education/
11. teaching methods/
12. health promotion/
13. exp formative evaluation/
14. program development/
15. program improvement/
16. summative evaluation/
17. Program Evaluation/
18. program effectiveness/
19. Duplication/
20. Programs/
21. Program validation/
22. Outcome measures/
23. "Outcomes of education"/
24. Pretests posttests/
25. Educational assessment/
26. Educational quality/
27. "replication (evaluation)"/
28. program guides/
29. program implementation/
30. program design/
31. Programmed Instructional Materials/
32. exp Instructional Materials/
33. material development/
34. Instructional Material evaluation/

- 35. exp training methods/
- 36. training/
- 37. trainers/

Embase

CHW Group (Population)

- 26. exp Health Auxiliary/
- 27. Health educator/
- 28. Diabetes educator/
- 29. exp Health care manpower/
- 30. Health care personnel
- 31. exp Traditional birth attendant/

LMIC Group (Population)

- 145. exp Lowest income group/
- 146. exp Developing country/
- 147. exp Africa South of the Sahara/
- 148. exp Southeast Asia

NCD/CVD Group (Intervention)

- 25. exp Cardiovascular disease/
- 26. exp Non communicable disease/
- 27. exp Chronic disease/
- 28. exp Diabetes Mellitus/
- 29. exp Hypertension/
- 30. exp Obesity/
- 31. exp hyperglycemia/
- 32. Weight gain/
- 33. Diet/
- 34. Western Diet/
- 35. exp Hyperlipidemia/
- 36. Alcohol consumption/
- 37. "tobacco use"/
- 38. tobacco dependence/
- 39. physical inactivity

Training Programs Group (Intervention)

- 2. exp Health program/
- 3. exp Education/
- 4. exp Accreditation/
- 5. exp Health education/
- 6. exp Medical education/
- 7. exp Teaching/
- 8. exp Staff training/
- 9. exp Training/
- 10. exp Program evaluation/

CINAHL

CHW Group (Population)

- 26. Community Health Worker
- 27. Lay Midwives
- 28. Community Health Services

LMIC Group (Population)

- 145. Developing Countries
- 146. Africa South of the Sahara
- 147. Asia, Southeastern

NCD/CVD Group (Intervention)

- 25. Alcohol Drinking+
- 26. Cardiovascular Diseases+
- 27. Cardiovascular Risk Factors
- 28. Cerebrovascular Disorders+
- 29. Chronic Disease
- 30. Diabetes Mellitus
- 31. Diabetes Mellitus, Type 2
- 32. Diet
- 33. Diet, Western
- 34. Hyperlipidemia+
- 35. Life Style, Sedentary
- 36. Lipoproteins, LDL+
- 37. Obesity+
- 38. Prediabetic State+
- 39. Smoking Cessation Programs
- 40. Tobacco Products+

Training Programs Group (Intervention)

- 2. Education+
- 3. Program Development+
- 4. Quality Assessment+
- 5. Professional Development



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4,5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Yes
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5,6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6,7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6,7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ for each meta-analysis)	6,7,8



PRISMA 2009 Checklist

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8-14
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	14,15
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	11, Figure 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Due to heterogeneity of data, a meta-analysis was not done.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	14,15
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Not applicable
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	16,17,18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	18,19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	19,20
FUNDING			



## PRISMA 2009 Checklist

Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	21
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From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: [www.prisma-statement.org](http://www.prisma-statement.org).

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